APPLIED HYDRAULICS

THE MAGAZINE OF FLUID POWER TRANSMISSION

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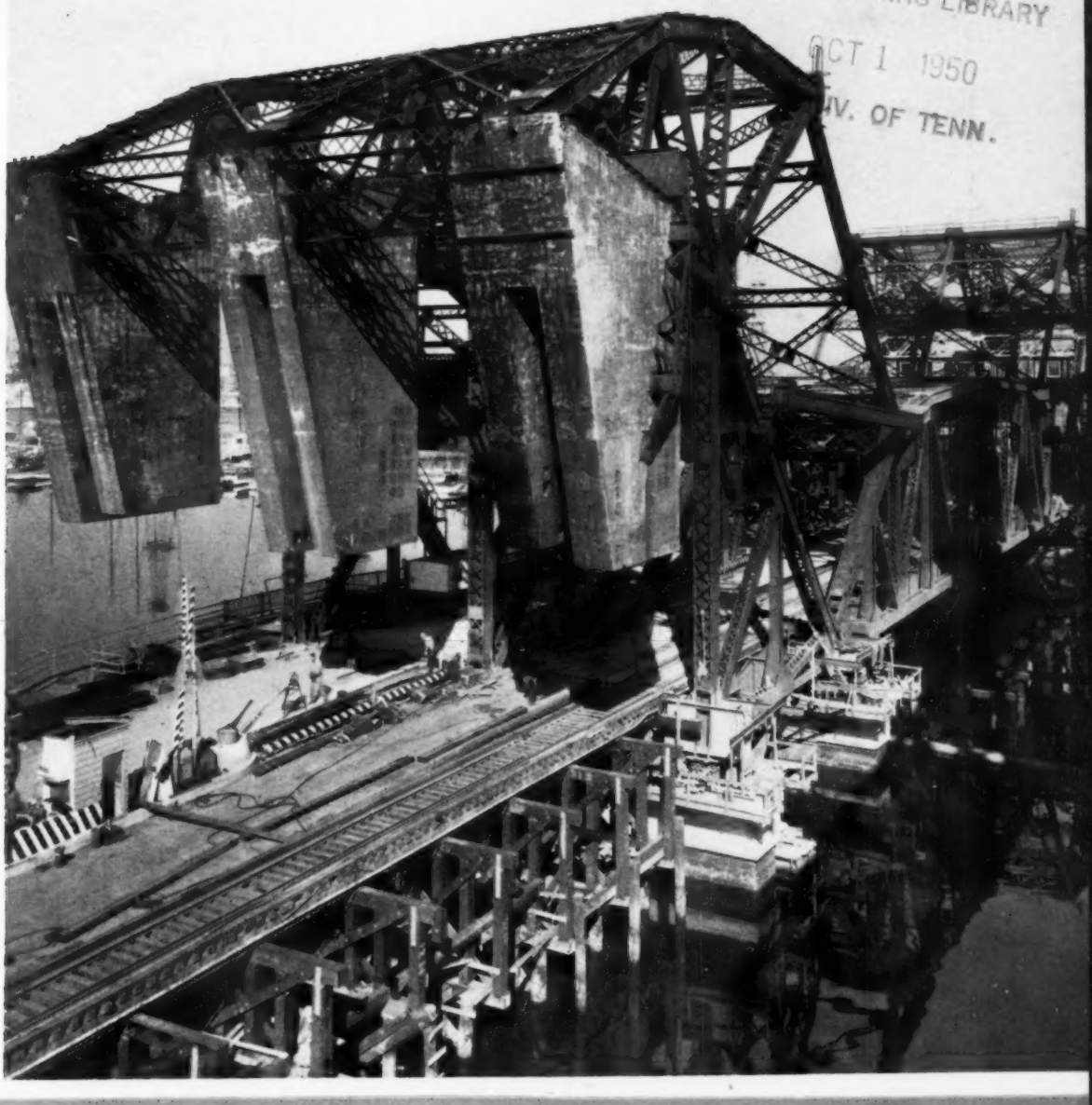
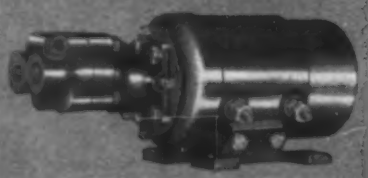


IN THIS ISSUE

RAISING TWELVE MILLION POUNDS WITH 12 HP, PAGE 11

TANDEM VACUUM-AIR CIRCUIT REDUCES INSPECTION COSTS, PAGE 14

Another Job for Pesco HYDRAULIC MUSCLES



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MAY, 1950
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APPLIED HYDRAULICS

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FRONT COVER: The Henry Ford Avenue Bridge, Los Angeles harbor, after center span was raised 7½ feet. The task involved raising the center span, building four concrete piers up to the new elevation, raising both railroad trestle approaches to the bridge and restoring traffic in the minimum of time. Story on page 11.

CONTENTS

Raising Twelve Million Pounds with 12 HP 11
By R. L. Hayman

Tandem Vacuum-Air Circuit Reduces Inspection Costs 14
By Miles Fryar

AVIATION HYDRAULICS SECTION
Basic Types, Characteristics and Applications of Hydraulic Systems for Aircraft 16
By Frank C. Mittell

BASIC HYDRAULICS SECTION
Compound and Pressure Reducing Valves, Chapter VI, Part 2 20

Theory and Practice in the Design of Hydraulic Seals, Part III 24
By R. O. Isenbarger

DEPARTMENTS

LETTER TO THE EDITOR 6
HERE'S HOW 18
NEW PRODUCTS 32
USEFUL LITERATURE 35
BOOK REVIEWS 40
DIGESTS 42
POST SCRIPTS OF INDUSTRY 45
MARKET PLACE 46

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LETTERS to the Editor

I am interested in two cylinders approximately three inches long and one-half inch in diameter, with a two-inch lift, capable of lifting ten pounds. This is for a scale model of a piece of materials handling equipment. Incidentally, I would also be interested in a miniature pump to use in conjunction with the cylinders. Any information you can give me will be greatly appreciated.

H.L.B.

The names of several organizations who make such special hydraulic cylinders and pumps have been forwarded to you.

Does the revised JIC Hydraulic Standards section on heat exchangers (H5.5) in which the use of copper or copper alloyed metals in contact with uninhibited petroleum base fluids apparently is approved when these metals are compatible with such fluids mean that copper tubing might be used elsewhere in the system?

B.D.

This problem, since it involves an exception to the Hydraulic Standards, would have to be solved by an agreement between supplier and purchaser.

Please accept my thanks for the valuable leads for obtaining information and literature on basic hydraulics. All of the people that you suggested that I write to have been most generous with their literature and suggestions.

R.B.B.

(See letter of R.B.B. in this column for April.)

Have the symbols used in recommended diagrams of JIC Hydraulic Standards been published separately? We would use four or five such sheets to good advantage.

T.R.

Yes; at least two manufacturers in the field have done this. We are sending their names to you.

I am interested in finding a flexible coupling to use between a 2 hp motor and pump. Your magazine is very helpful on hydraulic information, but, unless I have missed something, there hasn't been any flexible coupling information listed. Have you any information that would give me a comparison of flexible couplings?

T.C.F.

We do not know of an independent comparison that has been made on flexible couplings. A number of the manufacturers of couplings have published test results in their literature or as engineering data sheets. The names of several manufacturers who

offer such information has been forwarded to you.

We like the "Here's How" items in APPLIED HYDRAULICS. Let us have more of them each month.

J.L.
B.S.

This we plan to do. These items cover a wide field; not only maintenance or service problems but designs and production shortcuts as well. Our readers are invited to send their pet time or effort savers to the Here's How Editor.

The articles by Mr. G. W. Louthan on the research done by Mr. A. M. Kellman, "Reduction of Hydraulic Noise and Vibration" are certainly interesting and timely. The introduction is a very clear discussion on the importance of doing something about the matter.

The noise and vibration described could be termed *hydraulic* in origin as distinguished from *mechanical.* For instance, in an ordinary commercial installation (not aircraft), noise and vibration of hydraulic origin would account for no more than 10 percent of the characteristic noise associated with the equipment. The rest would be mechanically transmitted directly from the pump and motors to the air and various sounding boards. Mechanically transmitted noise is by far the worst offender and cannot be licked by a pulsation filter. In aircraft, of course, the noisy pump is mounted outside on the engine, so that the problem is different.

In the discussion of pulsation filters, the article describes some evidence that horns did not operate satisfactorily. Perhaps that was because significant capacitance and inertance effects, both lumped and distributed, were unsuspected in the test set-up. The horn properly used, can definitely justify its extra cost and weight, if important.

F.H.A.

We welcome comments, such as the above, on the articles we publish.

Has there been a reprint of the article "The Selection and Application of High Pressure Pumps and Fluid Motors"? We could use two copies to good advantage in our sales work.

P.D.

Yes, this article has been reprinted. Copies may be obtained by requests directed to Mr. Vickery.

Additional answer to W.J.C. (Letters to the Editor column, March issue):

The names of two manufacturers of high pressure hose that have expressed an interest in your hydraulic pitman problem have been sent to you. We have also learned that at least one other manufacturer has a new hose under test in production, a hose that might be an answer to your problem. As soon as this manufacturer clears the information on this hose, we will be glad to advise you.

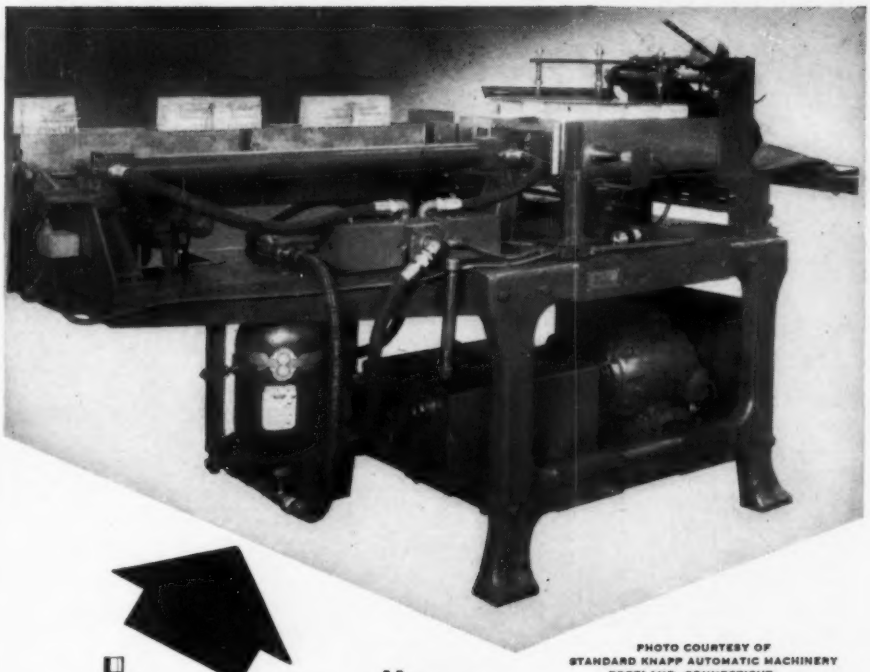

PHOTO COURTESY OF
STANDARD KNAPP AUTOMATIC MACHINERY
PORTLAND, CONNECTICUT

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How a GREER ACCUMULATOR Improved the Operation of This Packaging Machine

THE packaging machine shown above and manufactured by Standard Knapp is but one of many similar machines used to collect and ultimately insert various types of boxes, bags and bottles in containers according to predetermined patterns. This is accomplished in various ways, the most common being gravity or by means of a ram or pusher. The feed conveyor shown here brings the individual bags to a position in front of the side pusher which shears off the predetermined number. When the load pattern is in front of the main pusher it is transferred into the shipping container.

The two pushers were formerly operated mechanically by a slider crank mechanism. Redesigning the unit to incorporate hydraulic pushers and a Greer Accumulator resulted in many important advantages. The use of the Greer Accumulator resulted in:

1. A considerable saving in labor and materials.
2. A reduction in size of pump required.
3. A saving in space and cost.
4. Greer Accumulator provides the constant pressure so urgently needed for a positive transfer of the product.

Redesigning your own process or machine to incorporate a Greer Accumulator, you too can enjoy numerous advantages. Our representative in your territory will be happy to discuss your individual problems. A request for further information to our engineering department will bring an immediate reply.

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YOUR SYMBOL OF SERVICE

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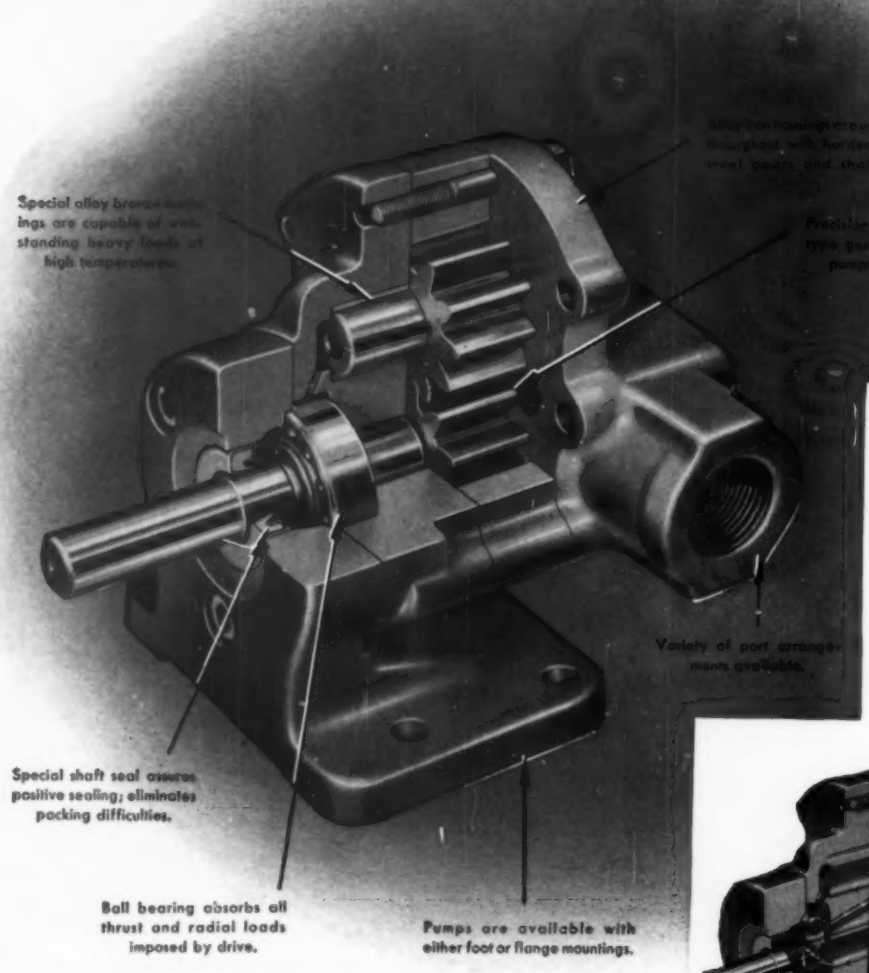
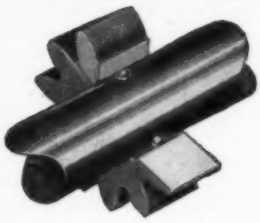
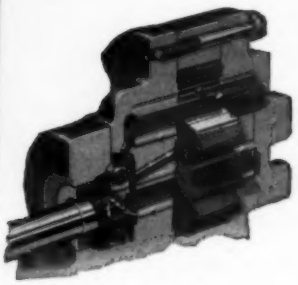
The "Inside Job" on the

New Adel Hydraulic Pump


Special alloy bronze bushings are capable of withstanding heavy loads at high temperatures.
Alloy cast housings are used throughout with hardened steel gears and shafts.
Precision-machined, involute-type gears assure highest pumping efficiency.
Pumps are internally drained. No extra plumbing is required.
Variety of port arrangements available.
Special shaft seal assures positive sealing; eliminates packing difficulties.
Ball bearing absorbs all thrust and radial loads imposed by drive.
Pumps are available with either foot or flange mountings.



A unique, ball drive permits gears to float endwise on shaft. This prevents any thrust loads from being transferred from shaft to gears or end plates.



Trapped fluid is utilized to pressure-lubricate shafts, bushings and bearings. This permits use of journal bearings, saves costs and maintenance. This provides smoother, quieter operation.

Here's a new series of gear-type hydraulic pumps designed and constructed to meet today's requirements for a simple, low cost, efficient hydraulic power source. Incorporating many exclusive design features, these new pumps are ruggedly built for long, trouble-free service under the most severe operating conditions. Adel hydraulic pumps are designed for 1000 psi service with rated capacities at 1800 rpm of from 1.5 to 60 gpm. Investigate them today!

Write for new, descriptive bulletin containing detailed information on ADEL's line of industrial hydraulic equipment. Please address inquiries to 10755 Van Owen Street, Burbank, California.

ADEL

DEL PRECISION PRODUCTS CORP.

RBANK, CALIF.

A FEW SELECT TERRITORIES ARE STILL AVAILABLE TO PROGRESSIVE DISTRIBUTORS OF HYDRAULIC EQUIPMENT - INQUIRIES INVITED

RAISING TWELVE MILLION POUNDS *WITH 12 HP*

A unique bridge raising job in which specially designed double acting hydraulic jacks and three piston radial pumps were used to raise a 6000-ton span in six inch increments.

By R. L. HAYMAN
General Manager
Haskel Engineering & Supply Co.

THE LIFTING OF THE 6000-TON center span of the Henry Ford Avenue double-leaf bascule bridge across Cerritos Channel seven and a half feet above its previous level was a triumph of ingenuity in which special hydraulic jacks and radial piston pumps played an essential part. Because of the importance of the bridge as the only railroad connection to Terminal Island, the main shipping center of Los Angeles harbor, the job had to be done in five days—120 hours.

The prelude to the 120 hour drama of engineering was played by the forces of nature over the past several years, during which time the bridge and adjacent land area had sunk approximately five feet. The subsidence, believed to have been caused by heavy withdrawals of oil and gas from under the harbor district, had been so slow that considerable time elapsed before it was realized what was happening.

About two years ago, however, binding on the giant center span became so great that lifting of the double leaves for passage of ships through the channel was impossible. After considerable study by the Harbor Department, it was decided to raise the existing bridge rather than replace it with a new one. General specifications and plans were prepared, leaving wide latitude to prospective bidders in the engineering processes to be employed.

The job involved raising the center span, building four concrete piers up to the new elevation, raising both railroad trestle approaches to the bridge and reconstructing the grades and tracks for immediate rail service to industrial plants, shipping companies and naval facilities on Terminal Island—all in 120 hours.

The task performed was unique. The lifting machinery and equipment had to be specially designed and manufactured. The project involved movement of ponderous masses. Yet operations had to be conducted with precision on the part of both men and equipment not normally found in the construction field. Hazards were large. Contractors were required to cover their risk with a $1,750,000 insurance policy against failure.

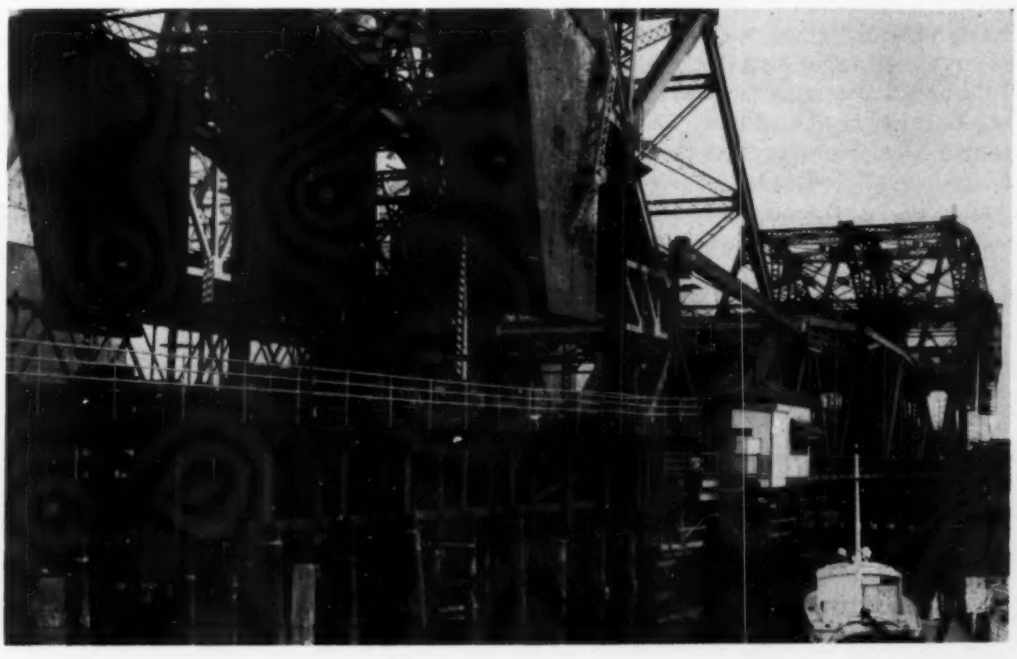


Fig. 1. The Henry Ford Avenue bridge before the double-leaf bascule center span was raised. The approaches are at the new level — 7½ feet above the old level. The massive concrete counterweights are a part of the center span.

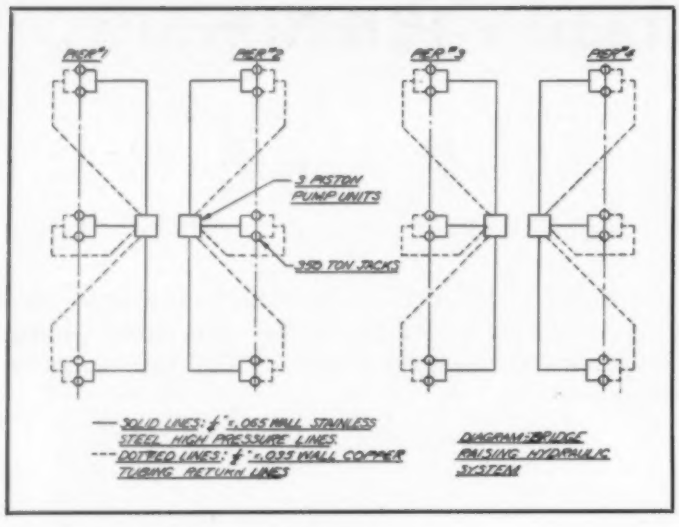

PIER 1
PIER 2
PIER 3
PIER 4
3 PISTON PUMP UNITS
350 TON JACKS
SOLID LINES: ¾" x .065 WALL STAINLESS STEEL HIGH PRESSURE LINES
DOTTED LINES: ¾" x .035 WALL COPPER TUBING RETURN LINES
DIAGRAM OF BRIDGE RAISING HYDRAULIC SYSTEM

Fig. 2. Schematic diagram of the bridge raising hydraulic system showing arrangement of jacks and pumps on the four piers.

Of greatest importance, the achievement saved an expenditure of millions of dollars to replace the massive double-leaf bascule bridge, in order to reopen Cerritos Channel water traffic that had been cut off for more than two years.

The Johnson-Western Company of San Pedro and the Tavares Construction Company of San Diego, jointly, were awarded the half-million dollar contract. Long months of advance planning and technical preparatory work were necessary.

The prime contractors decided to raise the span by power hydraulics, rather than by hand-jacks, since neither the available areas of the pier heads nor the time limit would have permitted their use. R. Howard Annin of Los Angeles was retained as consulting engineer in the structural and design analysis; the Haskel Engineering and Supply Company of Glendale was called upon to design special hydraulic jacks and pumps to lift the 6000-ton center span of the bridge.

The Hydraulic Problem

The major problem in raising the bridge by power hydraulics was that of synchronizing the jacks. After preliminary engineering analysis of the steel bascule bridge to determine what stresses and strains would be induced by the lifting operations, it was decided that synchronization would have to be precise to within ¼ inch in height between twelve jacking points.

Twelve jacking points, three on each pier, made the selection of 24 jacks about the most practical number to use. Space limitations dictated maximum working pressure of about 15,000 psi. Since no standard power pumps were available for this pressure and since the synchronization required a different approach, special pumps were built for the job.

The problem of synchronization was most difficult because the load varied between jacking points as much as one-third. In order to achieve synchronization, it was determined that only one piston in a pump could serve any one jacking point. Radial piston pumps were designed with individual outlets from each of three pistons so that, as the shaft rotated, each piston produced the same amount of oil regardless of pressure to each jacking point. Accordingly, four power units were built, each one with a three piston pump. Each piston from a pump served one jacking point and the pumps were all started and stopped simultaneously.

The pump pistons were made from case hardened stainless steel, extremely small in diameter, with a very long over-lap and were run inside of a case hardened stainless steel sleeve which was packed off to hydraulically balance it in hoop tension so that the high pressure did not expand the sleeve. At the extreme pressures encountered there was very little, if any, noticeable slippage past the pistons. Each piston served two jacks at one jacking point and the effective gear reduction, i.e., ratio of piston area to jack area, was about 3500 to 1. Four 3 hp motors were more than ample to lift the bridge.

At this extreme pressure, compressibility of the oil was quite noticeable. Although the pump pistons themselves always pumped exactly the correct amount of oil to each jack, the check valves in the pump would have to be changed frequently to keep them from leaking as the extreme pressure tended to ring the balls and allow a certain amount of leakage.

The jacks had a ram diameter of 9½ in and a bore of 10 in; the total stroke was 8 in. Figure 2 shows a schematic diagram of the arrangement of the jacks and pumps. Pres-

Fig. 3. One of the special 350-ton double acting jacks in action. The top of the jack is fastened through a ball joint to the bridge itself; when the jack has made its lift, shoring is placed between the bridge and pier and the bridge is dropped back about 1/16 in on the shoring.

sure was exerted on both sides of the jack piston head so that the ram diameter was the effective area.

When the jack had run its full stroke, shoring was placed between the bridge and pier and the bridge dropped back onto the shoring, usually about 1/16th of an inch. After the bridge would rest on the shoring, pressure would be diverted into the upper end of the jack and the lower end opened to return. The jack ram would then haul up the jack housing. In other words, the ram would remain stationary and the housing and jack would rise. When the jack was then fully raised and dangling in mid-air from the bridge, shoring would then be put under the jack. In this way it was never necessary to manually lift the jacks to start another 8 inches of stroke.

The pressure lines from the power units to the jacks were of ¼ in stainless steel tubing with a wall thickness of .060, which left only ⅛ in diameter opening in the line. Although the amount of fluid being pumped was extremely small, it was necessary to go to aircraft hydraulic oil after the operation had begun because the temperature dropped to around freezing and the regular hydraulic oil got so viscous that pumping pressures were going beyond the range of safety. It is estimated that some pressures in the neighborhood of 35,000 psi were encountered during the operation.

The jacks were designed to include built-in release and check valves which would automatically lock the jacks at any point during the lift, should a feed line be broken. Figure 4 shows the details of the jack design.

The five-day period for lifting of the center span of the bridge and the restoration of railroad transportation had to be set for the most favorable tidal conditions, since the four piers were under water at high tide due to the subsidence.

Finally, with delivery of special equipment for the raising of the big span, the time arrived for a test lift. Steel bed plates were grouted in place on top of the four piers to support the 24 jacks. The jacks were lifted by crane, lowered through openings on each side of the roadways and swung to workers on scaffolds hung alongside the piers. The jacks were then set under each of the three bearing points on each pier by enclosing them in heavy steel jacking boxes. These, in turn, were bolted both to the steel bed plates on the piers and to the bottom of the bridge deck.

Next, two of the special pumps were placed on each side of the steel bridge span, each pump powered by 3 hp motors and feed lines were installed, lines going to six jacking points from each pump (Figure 2).

The third step was the installation of an elaborate loudspeaker system, connecting all jacking points, enabling one man to direct operations with a microphone.

During the lifting operation, three workers were stationed at each jacking point, connected by an intercommunication telephone with a foreman on each of the four piers. In this way operations were correlated

(Continued on page 31)

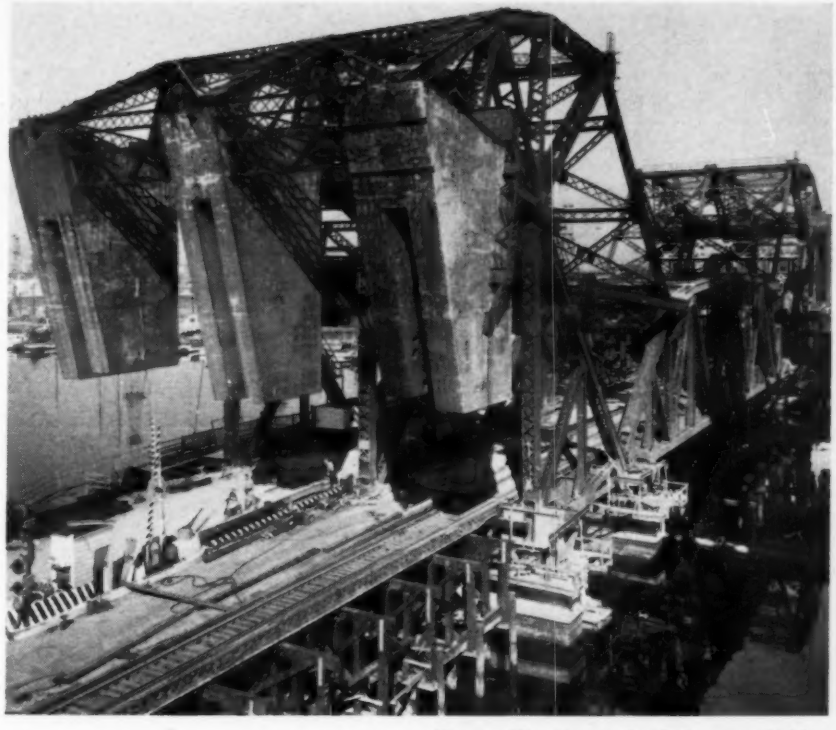
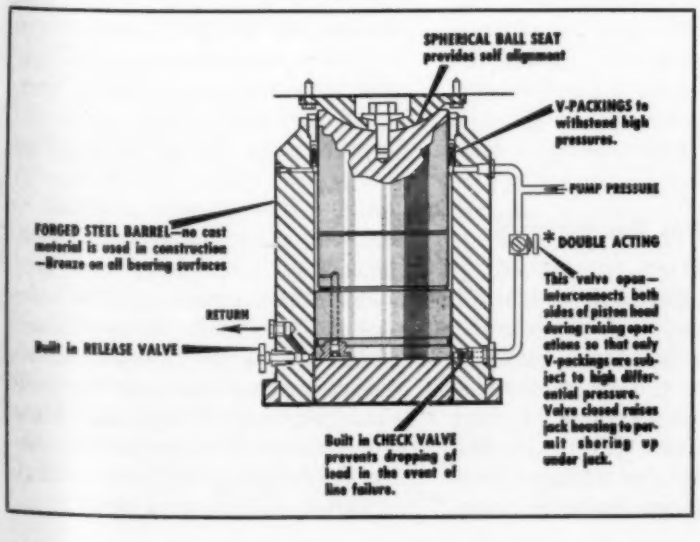


Fig. 5. The Henry Ford Avenue bridge after the center span was raised 7½ feet. The 2½ foot pier increments are clearly visible. The entire job was done in 120 hours, around-the-clock, to restore critically important traffic.

Fig. 4. Detail of the special jack design.


SPHERICAL BALL SEAT provides self alignment
V-PACKINGS to withstand high pressures.
PUMP PRESSURE
* DOUBLE ACTING
This valve open—interconnects both sides of piston head during raising operations so that only V-packings are subject to high differential pressure. Valve closed raises jack housing to permit shoring up under jack.
FORGED STEEL BARREL—no cast material is used in construction —Bronze on all bearing surfaces
RETURN
Built in RELEASE VALVE
Built in CHECK VALVE prevents dropping of load in the event of line failure.

TANDEM VACUUM-AIR CIRCUIT REDUCES INSPECTION COSTS

The use of a hardness tester, modified for production use, for operation by vacuum and air pressure, to increase the rate of production testing from one-third to nearly one-half.

By MILES FRYAR, Methods Engineer
Industrial Engineering, Tapco Division
Thompson Products, Inc.

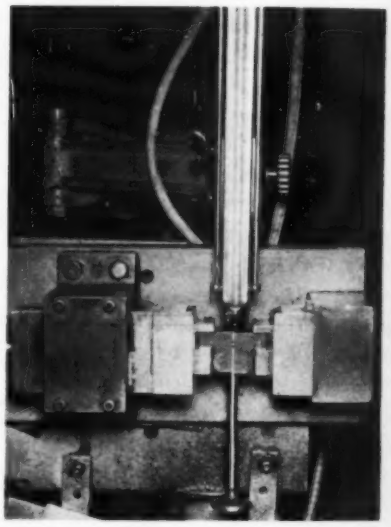


Fig. 1. Front of the modified hardness testing setup, showing a valve stem in position for testing. The movable jaw (left) is operated by the movement of an air cylinder (see Figure 2).

ONE OF THE MAJOR PROBLEMS in the inspection of valves at the Tapco Plant of Thompson Products, Inc., was the cost of 100 per cent testing of valve stems for hardness. Laboratory instruments, unsuitable for production work, had a short accuracy life and required frequent changes for calibration, reducing the number of parts tested per shift and adding to the cost. The technique described was a development which overcame the inherent delicacy of the indicating instruments and at the same time very appreciably increased the actual average output of inspection—47 per cent for single blow tests and 37 per cent for three blow tests.

While the single blow testing was specified for testing hardness on most valves, some specifications called for three blow tests. Initial efforts to accelerate the three blow tests in particular were made, since such tests slowed up inspection considerably and held up production lines.

A standard rebound reading hardness tester was used originally in its as-received condition for the testing. This instrument is essentially a device for testing surface hardness by measuring the rebound of a diamond-tipped hammer falling from a fixed height. The hammer falls free in a glass tube, the front face of which has a scale graduated in 140 divisions. The height of rebound is determined by visual inspection. The swing arm on which the instrument is mounted is used for testing large and heavy work. The unit is normally set up on its own clamping stand or on a special fixture designed for handling parts to be tested.

In the original tester the hammer is held by a pair of fingers in the head of the tester. When ready to drop, the fingers are released by cam action motivated by air pressure applied by squeezing a rubber bulb by hand. The hammer, after being released, is free to fall by gravity until it hits the specimen being tested. The height of the rebound as previously stated determines the hardness of the specimen. A second squeeze on the rubber bulb returns the hammer to its original position.

Difficulties Encountered

The original set ups utilized the instrument as designed. Several difficulties developed for production testing. First, the hardness tester is a rather delicate instrument and it was frequently necessary to check it for calibration. Originally this meant stopping the testing, removing the instrument from its clamping stand or fixture, taking it to the tool crib, returning and remounting the instrument. This took at least ten minutes and it was not unusual for four or more changes for calibration to be made each 8-hour shift. Second, the gains made in mechanizing handling of valves ahead of this testing made this operation a bottle-neck. It became essential to speed up the testing operation. Third, the instruments, while easy to operate, required a detailed series of hand operations for each blow, which had to be repeated in sequence approximately two thousand times per hour all shift long. Since girl operators are used for this testing, the fatigue problem was critical.

Various efforts were made to in-

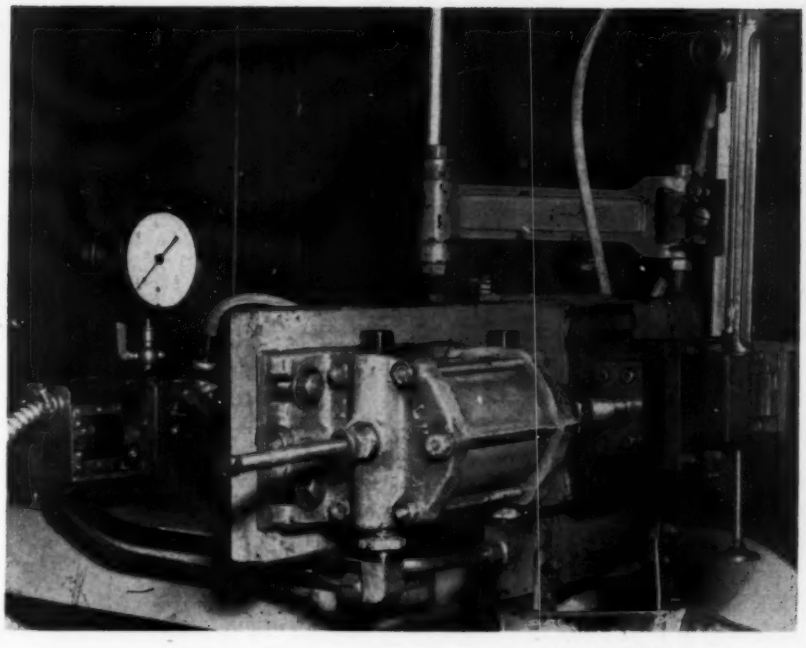


Fig. 2. The double acting air cylinder, operated at 30 to 40 psi, opens and closes the movable jaw. The solenoid of the 4-way special air valve is shown at the left.

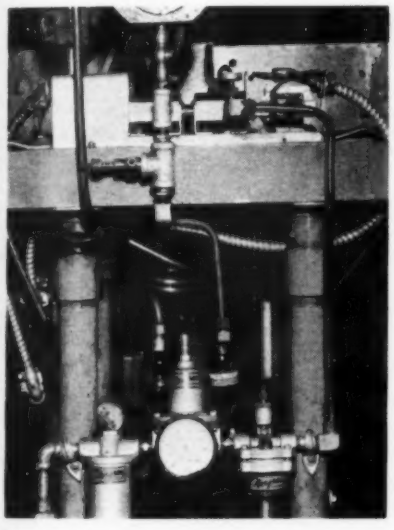


Fig. 3. The special two body, four-way valve (cover removed from the vacuum side) are seen top; the lubro-control unit and the vacuum pump. The "corkscrew" is the oil condenser.

corporate small design changes, to add various types of special clamps or vise-type fixtures or to furnish special jigs for loading and unloading. These met with varying success, none of which were too promising or which completely solved the essential problem of increasing the rate of testing.

Finally it was determined, after much cut-and-try, to use a special head that would permit vacuum operation of the hammer mechanism. The special head, a joint development of our tool engineering and industrial engineering departments, eliminated most of the intricate mechanical parts in the original head.

The system as finally worked out and which has proven very satisfactory, was a tandem vacuum and air circuit; the vacuum part of the cycle operating the hammer mechanism; the air pressure part of the cycle the double acting cylinder to open and close the vise jaws. The key to the double circuit was a special arrangement of a double solenoid, momentary contact controlled air valve. This valve consisted of two valve bodies, the pistons of which were connected by a heavy rubber grommet so that the pistons operate together or function as one valve. The valve operates on momentary solenoid contact, the instantaneous action permitting balancing without holding relays, bypass circuits or speed controls. Since the valve operates on vacuum, a pressure as low as one pound or as high as 150 psi, a very simple circuit was both possible and practical.

In the modified head the fingers were eliminated. The hammer was held at the top of the column by a vacuum. Cutting off this vacuum allows the hammer to fall and check the hardness of the piece. By the use of the four way valve in the circuit which is coupled into electric solenoids, the vacuum is again applied to the top of the instrument returning the hammer to its original position.

The special valve operates alternately as a vacuum and as an air pressure circuit. Figure 4 shows the schematic arrangement. On one side a vacuum pump is connected to one port of one valve body; on the other side the corresponding port of the other valve body is connected to the shop air line.

The operation is as follows: The pump connected to the suction line creates a vacuum, moving the cam in the direction to allow air to enter the top of the glass tube and releasing the diamond-tipped hammer. With the cam in the opposite position, the top of the glass tube is closed excepting for the vacuum orifice which returns the hammer to its original position. The vacuum pump selected was more than adequate for the approximately 8 inches mercury vacuum required.

The air circuit line operated a double acting air cylinder, controlled by the air pressure side of the valve to open and close the floating jaw of a vise, which, when closed, held the valve stem in position for the test.

The cycle is entirely controlled by a double throw foot switch. A toggle switch is used to start and stop the pump. With the pump operating, the operator inserts the valve stem into position against the fixed jaw of the vise (Figure 1) and depresses the switch. The cycle is automatic—

(Continued on page 30)

AVIATION HYDRAULICS

MAINTENANCE
DESIGN
OPERATION

FRED O. HOSTERMAN
Advisory Editor

Basic Types, Characteristics and Applications of Hydraulic Systems for Aircraft

By Frank C. Mittell
Hydraulic Engineer
North American Aviation, Inc.

PRESENT DAY AIRCRAFT HYDRAULIC engineers are confronted with problems which only a few years ago would have been considered unrealistic or even fantastic. Aircraft design and performance have been revolutionized since the early nineteen forties, and this challenge to keep pace with such phenomenal progress being made by the aircraft industry must be met by hydraulic engineers as well as all other phases of design.

Generally speaking we are not prone to look back, even a few years, because we are so deeply engrossed in our present day problems, but for the sake of comparison let us look back at our aircraft hydraulic systems which were designed and used in the early forties. Landing gear retraction, wing flap operation and bomb bay door operation were probably the three basic functions requiring hydraulic power operation. There were a few other sub-system operations such as engine cowl flaps, power wheel brakes, aerodynamic spoilers and power nose wheel steering, but these sub-systems were considered more or less incidental depending on the type of airplane. Landing and take-off speeds and top speeds, by comparison, were low; therefore operating hinge moments were reasonable and speed of operation was not critical. These conditions resulted in low power requirements which meant that system operating pressures of 1000 psi and 1500 psi were considered ample. (See comparison chart)

Variable delivery engine driven hydraulic pumps had not been completely developed, therefore the designer had only to choose between the "closed center" (constant pressure) and the "open center" (pressurized only during operation) type of systems. Both of these systems necessarily had to employ the constant delivery type of pump.

Controls for the hydraulic system on airplanes in the early forties were fairly simple. The directional control valves for the various sub-systems were generally located in the cockpit with direct manual control, or located in close proximity to the cockpit with simple linkage control. Remote automatic operation and depressurization of the system were not required.

Surface control systems were conventional cable and linkage systems requiring only pilot effort which meant that hydraulic boost, or power, was not required to assist the pilot in controlling the airplane.

In view of conditions already mentioned it can be seen that the designer's problems were not too difficult. Proper selection of the power system was merely a matter of determining maximum power required for operating the landing gear, since this subsystem generally required more power than any of the other sub-systems.

By comparison the hydraulic designer of present day aircraft hydraulic systems is faced with far more complex problems. New developments such as higher operating

pressures, variable delivery pumps, solenoid operated valves and various other automatic operating units, have greatly helped the designer to solve his problems. These developments were all born of necessity to meet the new requirements.

One of the first problems confronting the designer on a new airplane is the proper selection of a power system. Even though there are only two basic types of power systems there are several variations of each, so the designer has a better choice to fit his particular needs. Basic types of systems are now classified as either "Non-pressurized" or "Pressurized" and the variations under each type are as noted below:

Type A. Non-Pressurized Systems

1. Open center—variable delivery pump control—system under pressure only when one or more services are operated.
2. Open center—constant delivery pump, pressure relief valve control—system under pressure only when one or more services are operated.
3. Closed center—variable delivery pump control—automatic or manual control provided for depressurizing—system depressurized only during "in flight" operations when none of the services are being used.
4. Closed center—constant delivery pump, pressure regulator control—automatic or manual control provided for depressurizing—system depressurized only during "in flight" operations when none of the services are being used.

Type B. Pressurized Systems

1. Closed center—variable delivery pump control.
2. Closed center—constant delivery pump, pressure regulator control.

There are a number of factors which the designer must consider when selecting the type of system best suited for a particular airplane. It is obvious that the hydraulic system requirements for a single engine trainer airplane would be quite different from that of a multi-engine bomber, or that of a transport and cargo airplane. After the type of airplane is known, certain detail requirements must be determined before the designer can begin to make a wise selection of both type of system and operating pressure. The following factors must be considered and determined before proper selection of the power system can be made:

1. Determine maximum demand, or power requirements.
2. Determine number of engine power pads available and power rating of each.
3. Determine number of sub-services.
4. Determine proximity of power system to sub-services.
5. Determine number of sub-services which may be required to operate simultaneously.
6. Determine if any service is required to operate during "in flight" operations.

Each type and class of system have characteristics which in some respects are the same, or similar, and in other respects quite different. These characteristics may be advantageous for one application and quite a disadvantage for another. For instance a non-pressurized, variable delivery pump control, 1500 psi system for a trainer airplane would have the following advantages: (1) minimum input hp to engine driven pump; (2) less heating of the fluid; (3) non-priority, i.e., simultaneous operation of two or more sub-services; (4) lower operating pressure which is generally assumed to be more trouble free; and (5) additional sub-services may be added without a major redesign.

If we should consider this type and class of system for a fighter, or bomber airplane, probably our first problem would be space limitations, and flow requirements for the larger diameter and greater displacement actuating cylinders. We would therefore immediately choose a class 3000 psi system in order to reduce the size and displacement of our actuating cylinders. The next important problem would be capacity; do we have sufficient power (number of engine power pads and power rating of each) for the maximum demand? If not, then it becomes necessary to store energy in one or more accumulators. Should this stored energy become necessary, then immdeiate consideration would automatically be given to either closed center pressurized or non-pressurized system. Choice between these two types would depend largely upon the "in flight" operation requirements of the particular airplane. If the airplane in question were a bomber, cargo or transport then the non-pressurized system would probably be chosen, since after take-off there would be no hydraulic requirements for the "in flight" condition. However, if the airplane in question were a fighter,

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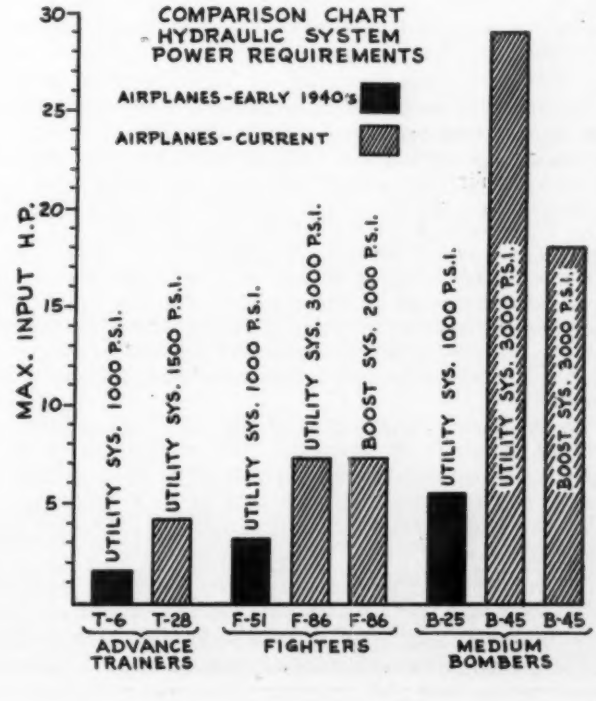

Comparison chart of growth of hydraulic power and pressure requirements in airplanes.

HERE'S HOW

- PREVENTIVE MAINTENANCE
- SERVICE PROCEDURES
- MODERNIZATION
- SHORT CUTS

An "After Christmas" Hydraulic Circuit

WE WERE CALLED into a plant where considerable trouble was being experienced in maintaining a hydraulic circuit for a simple pressing operation. The job, essentially, was to control the cycle of a hydraulic cylinder with a very short feed stroke under high pressure and approach and retract strokes at no resistance. A 3½ in diameter cylinder operated through a 1⅞ in stroke; the approach of 1¾ in and the return stroke of 1⅞ in had no resistance but for the feed or work stroke of ⅛ in, 9000 psi total force was required.

The job was being done (the maintenance man winced at this) by an arrangement shown in Figure 1. Granting that the installation was an awesome development to observe in operation, it represented quite an array of equipment to adjust and maintain.

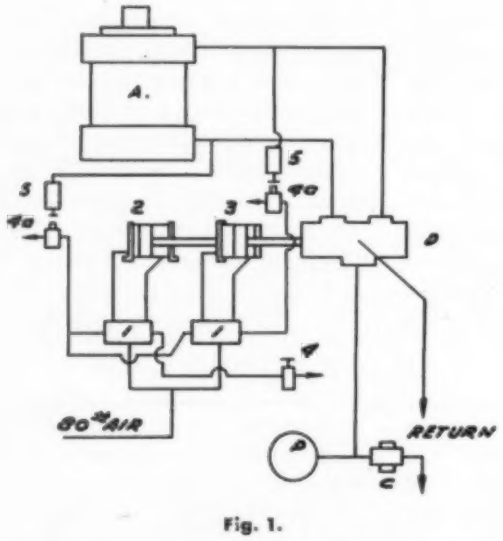

Fig. 1.

Primarily, the setup was an air controlled hydraulic circuit with an arrangement of two air cylinders in tandem controlling the stroke of a stem operated four-way open center hydraulic valve. Air cylinder 2 is fixed, air cylinder 3 is floating, their pistons acting to divide the stroke of the valve D stem travel. These cylinders were operated by separtae pilot operated 4-way air valves, 1, 1; their pilot air valves 4a, were adjusted to trip at a preset pressure by screw adjustments on hydraulic gauges, 5,5. The cycle of operation was initiated by depressing the treadle of pilot air valve 4. The four-way air valves were supplied by 80 psi air, the pilot air valves 4a acting as exhaust for the air circuit.

The hydraulic circuit consisted of a 1000 psi constant delivery pump, P, the four-way valve, a 1000 psi relief valve and piping system as shown. A neutral position of the hydraulic valve, to unload the pump as shown, was obtained by applying pressure to opposite ends of the two air cylinders.

After the maintenance man wore out, the Christmas tree was dismantled and the system was changed to the circuit shown in Figure 2.

A straight-way solenoid valve was used as the essential control. A holding relay maintains the solenoid energized until a normally closed pressure switch contact is opened

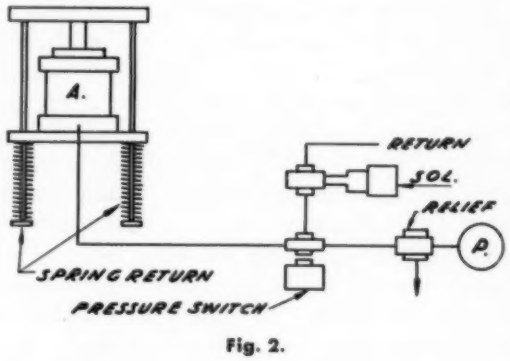

Fig. 2.

at a preset pressure. The relief valve controls the maximum delivery pressure; when the straight-way valve is opened the oil is dumped at zero pressure. Springs are used for the return stroke of the cylinder, also dumping through the straight-way valve.

This is a simple arrangement to do the required job and operates practically trouble-free. The same maintenance man who muttered in his beard about hydraulically operated machines is now seldom reminded that he has one in the shop.

E. F. HEISER
S. G. MORRIS
7829 Euclid Ave.
Cleveland 3, Ohio

Air Counterbalancing

COMPRESSED AIR is thought of as a medium to "push things around" but it is perfectly practical to use air as a counterforce to replace springs and counterweights. Often such a use may solve a vexing problem. If the cylinder can be proportioned correctly, it can "float" on the plant air supply line and cost practically nothing to operate.

We made such an application on a hydraulic press in which we had to exert an upward force of over three tons on a portion of a drawing die that traveled about six inches. This called for very long and very stiff springs. We solved the problem very nicely by connecting up two 6 in cylinders side by side through a link to the die, the cylinders floating on the plant air supply which averages about 100 psi, Figure 1. This system has been in operation for over ten years.

When the press descends on its power stroke, it forces the ram or male die downward, forcing the air in the cylinders back into the plant supply line. Since the volume of the cylinders was small in relation to the plant distribution line volume, the pressure was not raised noticeably. The time factor entered also, since the drawing operation consumed several seconds.

(Continued on page 38)

Readers are invited to contribute their short cost and labor saving shop or plant ideas. Each contribution will be acknowledged and considered for publication. We will pay $5.00 for each item published. —Here's How Editor

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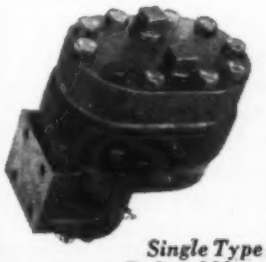
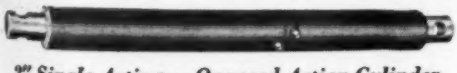


Single Type 2" Gear Motor Pedestal Mounting —6 to 9 H.P.



2" Single Acting — Opposed Action Cylinder 7" Stroke One End — 19" Stroke Opposite End

A SMOOTH-RUNNING constant speed gear type oil hydraulic motor motivates the reciprocating tooth blade of the cutter bar in this outboard highway mowing attachment. Fewer wearing parts, made possible by eliminating mechanical direct linkage drives, and dampening of vibration are realities with the hydraulic drive. Simplified adjustment of the pressure relief valve installed in the hydraulic circuit permits setting for heavy or light mowing and protects the knife and sections from damage by debris. Fingertip controlled oil hydraulic cylinders raise or lower the cutter bar within full view of the operator between an angle of —55° to +95°.

Here is another application of oil hydraulics which makes for simplified design, more practical usage and longer life. The "Hydro-Mower" realizes these benefits by adopting as standard equipment "Commercial" Oil Hydraulic Products.

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The COMMERCIAL SHEARING & STAMPING COMPANY
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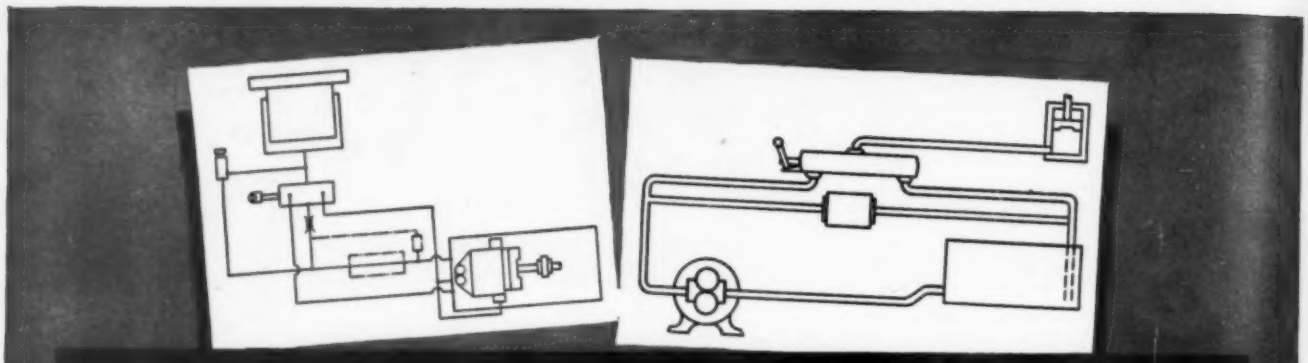

A Beginner's Course in Basic Hydraulics

COMPOUND AND PRESSURE REDUCING VALVES

CHAPTER VI

Compound Valves
Part 2

Balanced relief valve. The Vickers balanced relief (hydrocone) valve, Figure 81, consists of a main valve and a pilot valve, the latter set by an adjustment spring to open at a desired pressure. The valve is installed on the high pressure side of the pump and as near to it as possible. Pipe connections from pump and to work are directly open to each other to permit flow in either direction. Return line, bottom, should open directly to tank.

In operation where resistance of the work is less than the valve spring adjustment and the pressure does not exceed the valve setting, the piston will remain in closed position (as shown in Figure 81), oil will enter from pump, flow around the piston and out to work. At the same time, oil will flow through orifice 1, enter chamber 3, and create the same pressure on top of the piston as on the bottom. Since the area on both top and bottom of the piston is identical, the piston will be hydraulically balanced, and hold in the closed position by spring load. The liquid will also flow through orifice 2 to the pressure control poppet which is held closed by the adjustment spring. This condition will hold until the work resistance increases and causes a pressure rise that exceeds the adjustment spring setting.

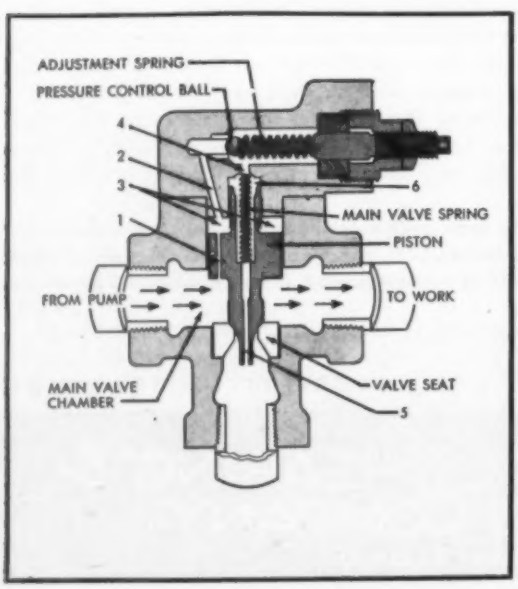

Fig. 81. Schematic view of balanced relief (hydrocone) valve. The main valve (vertical stem), pilot valve (top, horizontal) with adjustment spring and pressure control ball, return line (bottom) and differential orifices are shown. The valve is shown in the closed position. ***Vickers Inc.***

When the system pressure exceeds the adjustment spring setting, oil will flow from the pump inlet, through orifice 1, chamber 3, orifice 2, around the pressure control poppet which the excess pressure pushed out of its seat, and through the opening in the center of the piston to the tank. Then, because orifice 1 is smaller than orifice 2, the pressure in chamber 3 will drop below that of the main pump-work line, the valve piston will become unbalanced and begin to open. Opening of the piston permits oil to discharge directly from the inlet to the tank return. This release of excess fluid prevents further increase in system pressure.

When work resistance decreases and pressure drops below spring setting, the pressure control poppet will close and, as the oil continues to enter orifice 1, to equalize pressure again, the piston spring will push the piston down and close the discharge opening to the tank.

The Vickers balanced relief valve permits the use of a remote control

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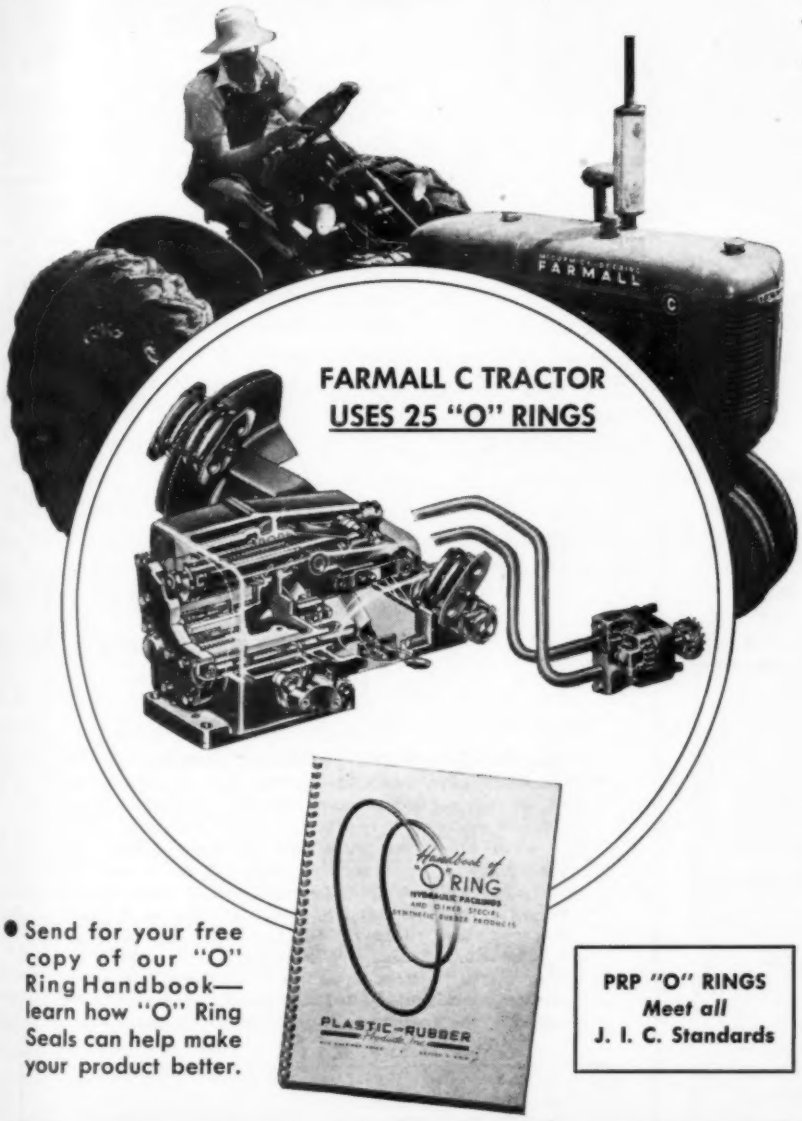

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for dropping the system pressure, e.g., at the end of a feed or power cycle. This procedure is called "venting". To vent a valve, the pressure is reduced on the upper side of the piston by connecting chamber 3 to atmospheric pressure by means of a small by-pass and a control or venting valve. When the venting valve is opened, a small volume of oil from chamber 3 will flow continuously to the tank, causing the valve piston to open and allow the pump delivery to discharge to tank at negligible pressure.

Simplex relief valve. Another compound relief valve is the Northern simplex relief valve, Figure 82. This valve works on the same principle as the Vickers balanced relief valve, in that a throttling or closing action of a pilot valve enables hydraulic pressure in the system to set up an unbalanced force on the seating force of the main valve, causing it to open. However, the result is brought about in an entirely different manner.

Figure 82 shows the simplex valve in the closed position, the pilot valve lies inside the main valve, the two units are connected by passages which are basic to the action of the valve. The design permits a small amount of leakage between the main valve and the valve body. The rectangles on either side of passage 4 are the lower part of the pilot valve plunger shown in section.

With both valves seated, passage 1 admits oil from the main pressure line by way of passage 2 to region 3 over the main valve. Passage 1 also admits oil by way of passage 4 to region 8 under the base of the pilot valve, as well as to region 9, under the upper part or land of the pilot valve plunger. By this arrangement, pressure in the main line is conveyed to the region *over* the main valve and *under* the pilot valve when both valves are seated.

In addition, passage 6 connects the region over the pilot valve plunger to the valve discharge and reservoir. This prevents oil which has leaked past the plunger from hydraulically blocking the upward movement of the pilot valve.

Under normal working conditions, the main valve is held closed because the horizontal area A of the main valve on which pressure acts downward is twice the horizontal area B on which pressure acts upward. The only purpose of the main valve spring is to hold the main valve closed when the system is not under pressure.

Figure 83 shows both closed and open positions of the main valve. At the left, with the main valve closed, the pilot valve is shown raised against the action of the pilot valve spring. At the right, the main valve is shown open. Assume the adjustment spring of the pilot valve has been set to limit the system pressure to 1000 psi. As system pressure is built up, the pilot valve will rise and at first restrict, then cut off the connection of passage 1 to other open areas inside the valve, limiting the pressure in regions 3, 8 and 9 to a substantially fixed value, in this case approximately 500 psi.

Then as the system pressure builds up further across the bottom face of the main valve in region 7, with the pressure on the top of the plunger remaining substantially constant as noted above, a point is reached where the force tending to hold the main valve closed is overcome by the force tending to open it. The main valve will then lift porting fluid from the pressure inlet to the discharge or reservoir. The lifting of the main valve is possible because of the leakage from region 3 down through the clearance space 5, separating the main valve from the

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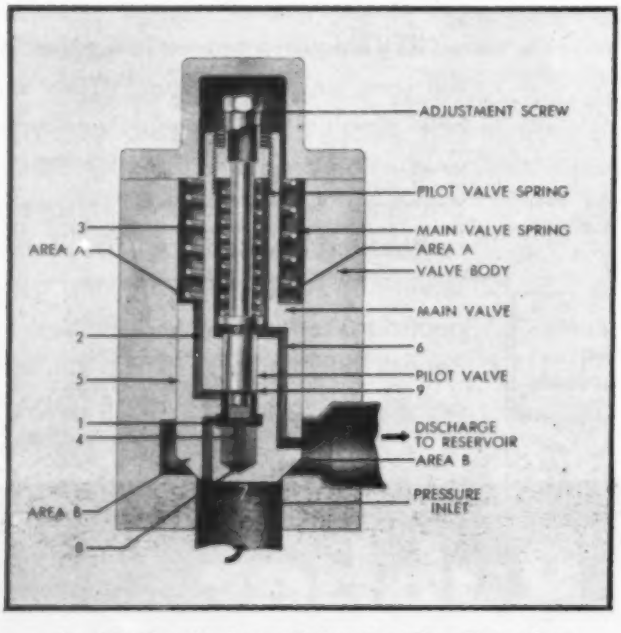
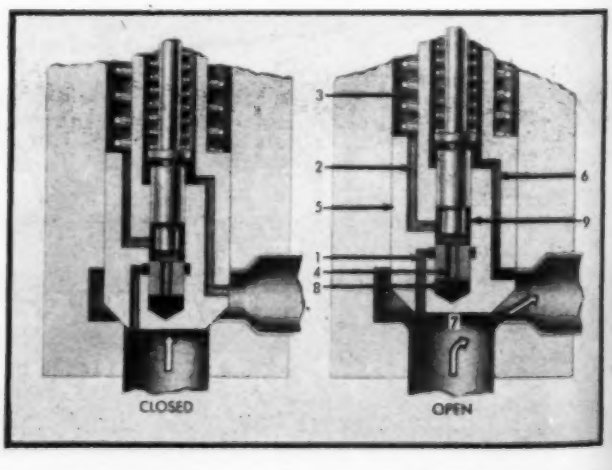


Fig. 82. The simplex relief valve. The pilot valve is inside the main valve; the arrangement of passages conveys mainline pressure over the main valve and under the pilot valve when both valves are closed. Passage 6 in a by-pass to drain for oil which has leaked past the plunger; small passage 5 is a permitted leakage outlet from region 3, both necessary to prevent hydraulic blocking of the upward movement of the pilot valve and the main valve. ***Northern Ordnance Inc.***

Fig. 83. Both closed and open positions of the simplex valve are shown. The pilot valve, rising at its spring adjustment setting, restricts, then cuts off passage 1; regions 3, 8 and 9 remain open to each other. At main line pressure above the spring setting, pressure in region 8 increases and the pilot valve rises. Leakage past 5 down main valve body decreases pressure in region 8, permitting pilot valve to descend, opening passage 1 and causing pressure in region 8 to again increase. This cycle continues, keeping pressure above main valve approximately constant and equal to the spring setting. ***Northern Ordnance Inc.***



NEW SUNDSTRAND "Cartridge" Type PUMP....

Here's a new Sundstrand PW Pump which consists of a variable displacement multi-piston pump and a constant displacement pump, both assembled in one compact unit. This pump with suitable Sundstrand J.I.C. valves may be used for either a piston and cylinder combination or a rotary fluid motor to transmit motion to moving members of a machine. If your design requirements include automatic or semi-automatic cycles, it will pay you to investigate a Sundstrand PW Pump.

Assembled and exploded view of new Sundstrand PW Pump. Note "cartridge" design.

Redesigned to J.I.C. Standards

This new pump design is based on many years of experience in the design and manufacture of hydraulic equipment such as pumps, valves, fluid motors, etc. With slight design changes it now meets the standards of the Joint Industry Conference.

BOTH Variable Feed Pump and Rapid Traverse Pump in One Compact Unit

A variable displacement multi-piston pump for feed rates and a constant displacement pump for rapid traverse are both contained in this one unit. As with most Sundstrand Pumps, the constant displacement pump consists of the patented Sundstrand Rota-Roll principle which comprises a roller revolving in positive contact with a rotor or ring. Since there are no gears nor sliding blades, friction is practically eliminated. The variable displacement or feed pump is of the multi-piston type and provides from 1 to 6 rates of feed . . . all adjustable from approximately zero to maximum. The feed rates are positive and uniform, pumps being built to supply the oil at high pressure without pulsation. A reciprocating motion is imparted to the pistons by a non-revolving wobbler plate. The wobbler plate is machined from a forging, hardened and ground. The pistons are hardened, ground, lapped and slid into mirror finished cylinders in a cast alloy cylinder block. Consequently, wear of moving parts is practically negligible.

7 Outstanding Features

1. "Cartridge" assembly . . . port housing, constant pump and variable pump are separate units mounted on a common drive shaft. Either pump may be removed for servicing without disturbing piping to port housing.
2. "Requirement" pumping . . . only the oil actually required for the work is pumped under pressure.
3. Easily installed . . . only piping required is to oil reservoir, actuated members and remote control valves.
4. Simple design . . . has only two revolving parts.
5. Self-lubricating.
6. Provides automatic and semi-automatic cycles—one, two or up to six feed rates, complicated operating cycles involving skip feed and feed in both directions.
7. Designed by men who know hydraulic and machine design requirements.

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FUEL UNITS • HYDRAULIC PUMPS • TRANSMISSIONS • FLUID MOTORS • VALVES and CONTROLS

Theory and Practice in the

By R. O. ISENBARGER

Part III

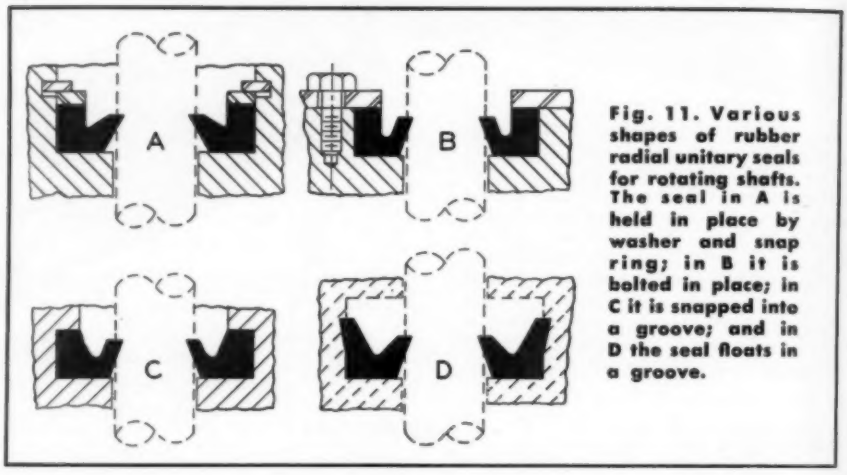

Fig. 11. Various shapes of rubber radial unitary seals for rotating shafts. The seal in A is held in place by washer and snap ring; in B it is bolted in place; in C it is snapped into a groove; and in D the seal floats in a groove.

Unitary Seals (Cont'd)

THE SEALS DISCUSSED PREVIOUSLY are primarily seals for reciprocating motion; some, as noted, may be used for rotary motion. In rotating applications, the friction is confined to a band around the shaft the width of the contact surface, so that heat build-up is not as rapidly dissipated as in reciprocating applications. This makes the combination of high pressure and speed in rotating applications a very difficult problem. If the other conditions are more than moderate, it becomes even more serious. Under such circumstances the seal engineer should always be consulted since it is difficult to make any generalities. With high speed and pressure on rotating applications, eccentricity should be kept to a minimum. Often, measures can be used to reduce the pressure which exists at the seal. For example, the pressure at the seal is often reduced by close clearances in conjunction with a bleed-off to a lower pressure point.

A type of unitary seal used principally in rotating motion, although it can be used also for reciprocating motion, is shown in Figure 11. This seal is normally used for sealing shafts as illustrated although it is sometimes used with the sealing lip on the outside diameter for sealing bores. The block-like portion is frequently clamped at the outside diameter as at A or B (if seal is used for sealing a shaft) to prevent leakage and rotation at this point. Often it is made somewhat oversized at the outside so as to fit tightly in a groove as in C. Sometimes this outside portion is shaped more like a lip but formed higher than the inside sealing lip so that it will not rotate, as shown in D. With this type of seal progress is being made for sealing higher pressures. At higher pressures the inner sealing lip is reduced as much as possible in height to reduce friction. A seal of this type has run at 2000 rpm and 1000 psi and with eccentricity of less than .001.

Radial Fabricated Seals

Fabricated seals, those assembled from more than one part, are made from various materials and are normally used for sealing rotating shafts. They are usually limited to moderate pressures except at low speeds, and may be conveniently divided into radial and axial seals. Figure 12 shows a variety of radial seals having a single assembled sealing member. These should be used for very low pressures except for seal shown in F which is a synthetic seal bonded in a shell. Seals of this type have been used for pressures exceeding 100 psi and relatively high speeds.

Seals shown in Figure 12 are designed for press fitting into the housing except D which is for press fitting on the shaft and running in a bore. This seal is used where assembly makes it difficult to assemble in any other manner. The seal at A is preferred for sealing from one direction only and consists of a flange member pressed against the shaft by means of a garter spring. B is a seal usually made with a beveled leather washer-type of sealing member for use on reciprocating shafts as a wiper seal, although in cases where concentricity is good, it often does a good job of sealing grease and heavy oil. C is a variation of A but using a finger spring to create the contact pressure; it is often used in applications where dirt would foul up a garter spring. The contact pressure of D is created by means of a piston ring although an expanding type of garter spring may be used. E is a dirt seal using a felt sealing member. The lip of F is often grooved to retain a coiled spring; often the spring is held in place by a washer over the top, as in A. By this means F may be made to take greater eccentricity.

Figure 13 shows various types of seals with double sealing elements. A combines an oil sealing flange with a dirt exclusion member. Type B is often used where assembly would turn the dirt exclusion member backwards. C is used for mud applica-

Design of Hydraulic Seals

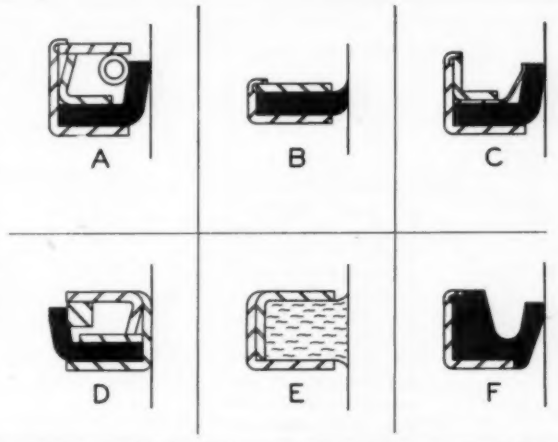

Fig. 12. Radial fabricated single sealing element seals. A shows a garter spring - loaded flange; B a non-spring loaded bevel washer seal; C a finger spring-loaded flange; D an external flange seal; E a felt seal; and F a rubber sealing element bonded to a shell.

tions. The top member seals out the dirt and the flange at the bottom seals water which passes the first member. D is a seal similar to A except that felt is used as a dirt excluding member; this type is used for sealing in both directions. E shows a seal for sealing in both directions. F is not often recommended in hydraulic work since if the first sealing member does a good job, the second one is not needed and will probably be starved for lubrication. However, it is sometimes used in cases where slight leakage is expected to pass the first sealing member.

Axial Fabricated Seals

Axial seals are designed in such a great variety of forms that only the general principles involved will be discussed. By definition, the contact pressure is in an axial direction in relation to the shaft. This means that the contact surface of the seal must be in a plane at right angles to the axis, so that instead of being cylindrical as in the previously discussed seals, it must be a flat surface capable of relative rotation with a similar mating surface of the machine called a mating spring. There are, however, some axial seals with spherical or conical surfaces. These will not be discussed. Assuming that the housing is stationary and the shaft rotates, either of two situations must exist; the seal is secured stationary with the housing (Figure 14A) with the mating ring which rotates with the shaft, rotating against the contact surface of the seal; or the seal is secured to the shaft (Figure 14B) so that its contact surface rotates against a stationary mating ring in the housing. The seal must prevent leakage from space 1 to space 2, from 2 to 1 or in both directions. In either case leakage must be stopped at four points—between the housing and the seal in A or between the shaft and seal in B; through the internal parts of the seal itself; across the contact surface; and between the mating ring and the shaft in A or the housing in B. The most vulnerable point is the contact surface; this surface and its mating surface must have a degree of flatness and smoothness depending upon their materials. At least one of the surfaces, usually the mating ring surface, must be relatively hard. For example, a resilient Hycar synthetic rubber surface of 90 Shore A durometer hardness running against a 60 Rockwell C steel surface polished to a mirror finish and a flatness of about .0002 in can stand a surface speed of 500 fpm with about 25 psi face loading if well lubricated. For higher speeds, it is necessary that both surfaces be hard and lapped to a flatness of from 20 to 50 microinches. Material combinations commonly used are carbon, bakelite, and certain cast and sintered bronzes run against carburized steels, Nitralloy, stainless steels, and Meehanite. Carbon is sometimes run against certain bronzes. Recently work has been done with glass and ceramics.

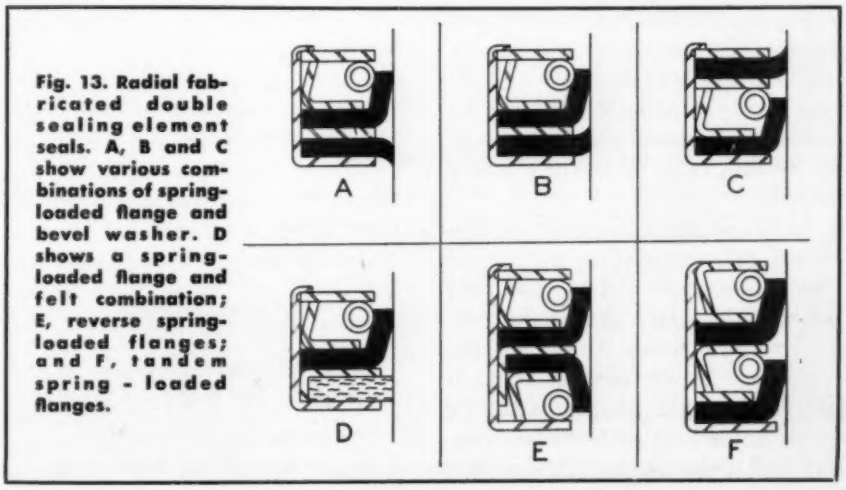

Fig. 13. Radial fabricated double sealing element seals. A, B and C show various combinations of spring-loaded flange and bevel washer. D shows a spring-loaded flange and felt combination; E, reverse spring-loaded flanges; and F, tandem spring - loaded flanges.

It is most important not only that the surfaces be lapped flat, but that they stay flat under all operating conditions. The provisions used to maintain flatness depend upon the severity of the sealing conditions. Often it is possible to use bearing races as the mating surface. Sometimes the mating ring may be clamped in place. A shoulder on the shaft can occasionally be used for the mating surface. However, more frequently it is necessary to float the mating ring on rubber in such a way that no distortion will take place.

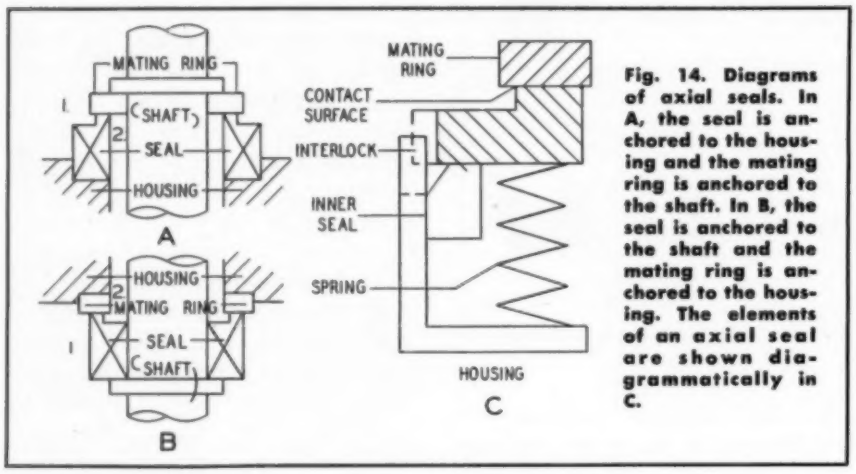

Fig. 14. Diagrams of axial seals. In A, the seal is anchored to the housing and the mating ring is anchored to the shaft. In B, the seal is anchored to the shaft and the mating ring is anchored to the housing. The elements of an axial seal are shown diagrammatically in C.

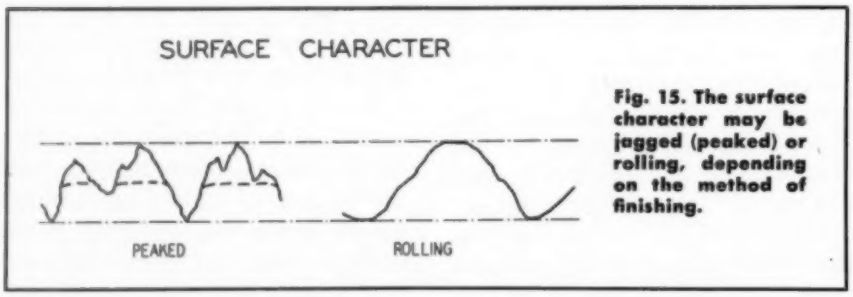

Fig. 15. The surface character may be jagged (peaked) or rolling, depending on the method of finishing.

Materials such as steel, which are liable to retain internal stresses, must be stress relieved and thoroughly seasoned before grinding and lapping. In order that the mating ring be stable, it should have a thickness axially of at least one tenth its diameter; for small shafts it should not be less than ¼ in thick where possible.

As far as the seal proper is concerned, the most obvious provision is that it be constructed so as to hold the contact surface against the mating ring at all times. To do this, the nose piece, i.e., the member containing the contact surface, must be spring-loaded or otherwise constrained to push against the mating surface and take up for wear and axial shaft movement or end play. This is illustrated diagrammatically in Figure 14C which also shows the other necessary seal elements. Besides having a spring-loaded axial movement the nose piece must be interlocked with the seal body so that it will not rotate relative to the body under the frictional torque at the contact surface. In allowing for the axial movement of the nose piece, in the seal body, an inner sealing member is required. Lastly, not shown, there must be some provision for locking and sealing the mating ring to the housing and the seal to the shaft or the mating ring to the shaft and the seal to the housing, depending on the type (A or B) of seal. In a given seal two or more of the above elements may be combined in a single member having the combined functions, and the elements may be arranged in an entirely different manner but an axial seal must have these basic elements. This seal will take much higher speeds than other types.

Desired Characteristics For Sealing Surfaces of Shafts

Shaft hardness, smoothness and material for the best sealing characteristics is really a specific condition. It is usually recommended that steel shafts should have a hardness between 45 and 60 Rockwell C. Hardened steel makes the best running surface. If it is necessary for the shaft to be made of such soft materials as copper, brass, aluminum, it is best to press fit a hardened steel ring on the shaft for the seal to run on. Sometimes it is possible to get a good chromium plated surface on such shafts; this surface should be as hard and thick as possible and should be a good grade of plating so that it will not flake off, wear, or groove.

Shafts which are centerless ground or lathe turned often have minute flat spots in the cylindrical surface caused by vibration in the machining. This makes sealing difficult. When specifying the proper shaft finish, consideration should be given to the character of the surface as well as the depth of the microscopic grooves. The usual specification of a shaft finish of 10 to 15 micro-inches refers to the depth of the microscopic grooves.

Figure 15 shows diagrammatically two surfaces having the same micro-inch reading. The first surface is jagged and would result in poor seal life. The second has rounded peaks and would probably be a good sealing surface assuming, of course, that the micro-inch finish was good. The two shafts would appear to the naked eye to be about the same except that the first one would have more of a satin finish and the second would be polished in appearance. Even fine grinding will often give a peaked surface. Polishing this surface has the effect of removing the sharp peaks as shown by the dashed lines. From a practical standpoint, it is best to specify the method of finishing. This finish can be acquired after grinding or fine machining to the proper finish by holding a piece of crocus cloth against the part, while it is rotating, moving it back and forth axially until a polish is acquired. As a last operation the crocus cloth can be held for a few seconds in one spot where the seal is to ride. This will tend to remove any microscopic spiral marks which would tend to pump the oil under the sealing lip of the seal.

Many seal failures are due to improper seal installation. Often insuf-

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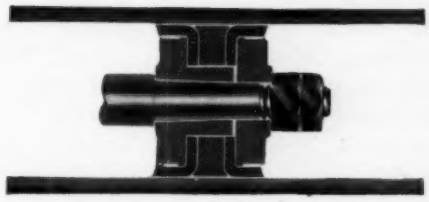
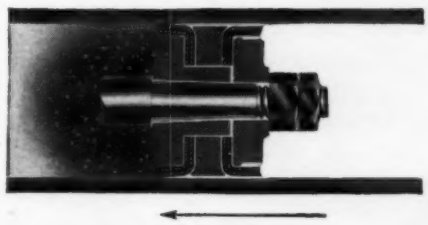
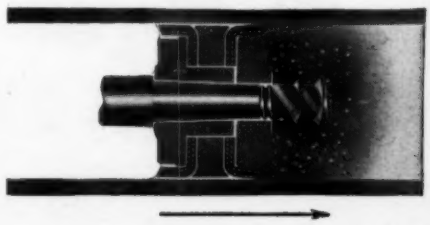


NORMAL: BOTH PUMCUPS RELAXED



UNDER PRESSURE: PUMCUPS SEAL AGAINST CYLINDER DESPITE WEAR, MINIMIZING SLIPPAGE



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ficient space is allowed for the seal with the result that the seal which fits the space is not efficient. The eccentricity previously referred to is called running eccentricity, i.e., the center of rotation is different from the center of the shaft. This type of eccentricity can easily be minimized in the design of the machine. Another type of eccentricity which causes seal failure is called assembled eccentricity, i.e., the center of the seal is not the same as the center of the shaft. This often occurs where the seal is press fitted into a cap which is then bolted to the housing without sufficient piloting. It is preferable to have the cap piloted in a bore which is machined at the same time as the bearing bore, or to pilot the cap in the bearing bore. Where possible, it is best to avoid the use of separate seal caps or retainers and to install the seal in bores which are machined at the same time as the bearing bores.

Seals should be installed so that their planes are at right angles to the axis of the shaft. Where press fitted seals are used, it is best to have them

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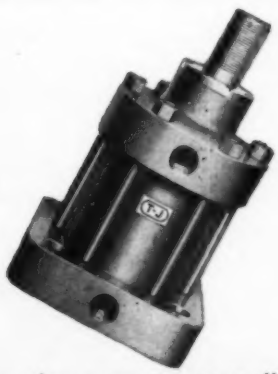
press fitted against a shoulder. Before assembly, seals should always be oiled as the damage caused by running a dry seal only a few minutes will inevitably show up as leakage later. It is also important, particularly with rubber seals, to be sure that they are lubricated. Where lubrication is sparse, particular attention should be paid to the type of sealing element used. Not only is it important, that running surfaces have good finishes, but clamping and press fitting surfaces should also be free from tool marks and scratches to prevent leakage. Often as an additional precaution Glyptal or Permatex or a similar sealing compound is used. Press fits should be avoided except at low pressures.

Seals should be kept in the containers as shipped by the manufacturer until they are used. It is bad practice to dump seals loosely in bins, the damage hazard is high. Care should also be exercised in handling, and seals should be kept free of foreign material. Many seals, especially lips, are damaged in assembly by passing them over splines, sharp edges, holes, shaft shoulders, etc. Where splines and holes exist, recommended assembly tools should be used.

The use of seals for any function except for sealing is to be discouraged. It is unwise, e.g., to use seals as bearings or frictional devices and at the same time expect them to seal. Since they are not designed for such use, they would be unreliable and their sealing ability would be impaired. An adequate bearing in the mechanism must be provided which will limit the eccentricity to the point required by the particular seal and the conditions involved; however, axial seals will take a greater eccentricity and will take this eccentricity at greater speeds than radial seals.



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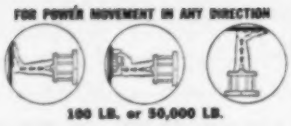

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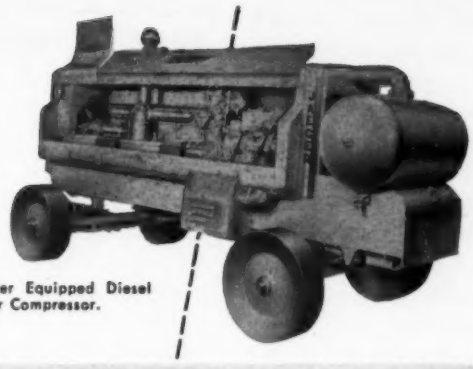

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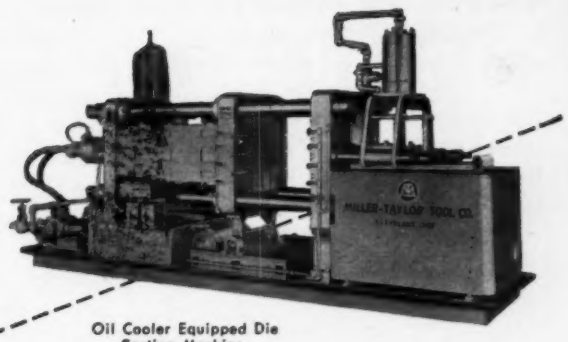

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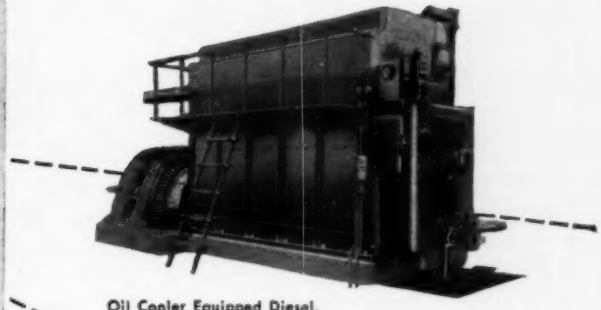

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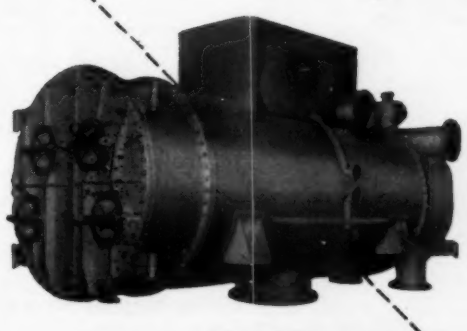

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VACUUM-AIR CIRCUIT

(Continued from page 15)

the release of the vacuum as noted, causes the hammer to drop, the test to be made, the valve to cycle, pulling a vacuum on the tube to return the hammer to its starting position.

Simultaneously, the air valve, connected to the shop air supply line, ports air to the rear piston end of the air cylinder, moving the rod on the end of which the floating vise jaw is attached to close the jaw on the valve stem.

When the operator removes her foot from the double throw switch, the solenoids are de-energized and the valves complete the cycle.

All sizes of valves made in the plant can be tested on the modified instrument without changes or adjustments other than the resetting of the stop nut on the air cylinder rod. This flexibility is important when several sizes of valves are run through the production line. Since the operation itself is one of the last inspections given, preceding only two final grinds and the final inspection, it is doubly important that no interruptions in steady flow of valves be made at this point.

This system is a development which met and solved a difficult production testing problem. The Tapco Plant now has seven automatic hardness testers with modified heads of their own design in operation. The set up described now does the major part of the hardness testing on valves in this plant. Increased capacity per machine per hour and per shift—one-third for three blow testing and nearly one-half for one blow testing by actual performances—have made fewer instruments necessary.

NOTE: *The modifications made to the head of the instrument used and the system as described are protected by patents owned by Thompson Products, Inc.*

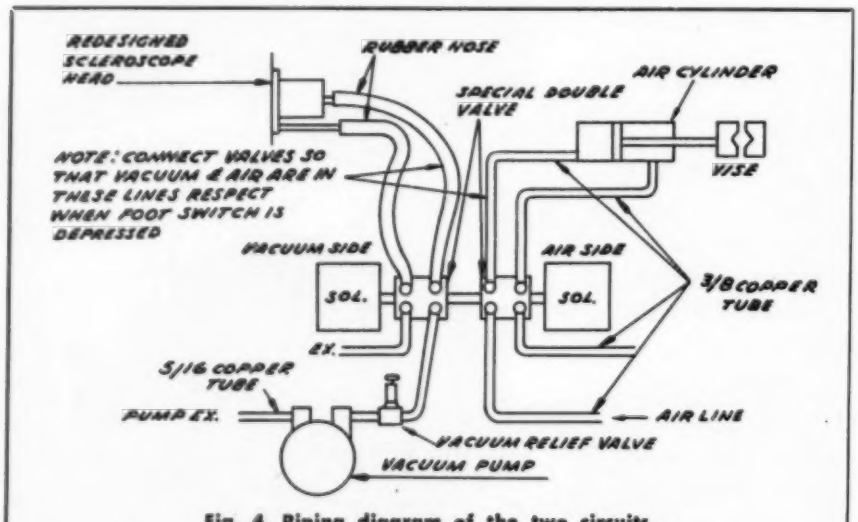

Fig. 4. Piping diagram of the two circuits.

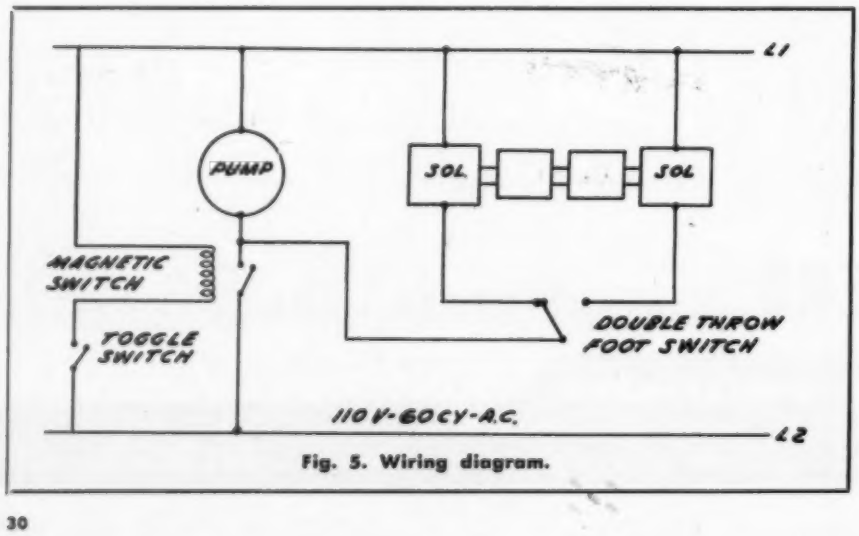

Fig. 5. Wiring diagram.

BASIC HYDRAULICS

(Continued from page 22)

valve body. Without this leakage the main valve would be hydraulically blocked. The volume of oil held in region 5 acts as a cushion to the valve action and serves to minimize instability.

Casualties with relief valves. An improperly operating relief valve will overheat, operate sluggishly or at the wrong pressure. The most frequent cause of trouble is the presence of foreign matter in openings or on seats. The valve will usually clean itself if the pump is started and the adjustment screw on the pilot valve is backed off a little by turning it counter-clockwise so that the pressure control spring responds to a lower pressure. The adjustment screw should never be completely removed from the system under pressure. After the flow of oil has cleaned the valve, the adjustment screw should be carefully reset by means of a pressure gauge. The relief valve should be set to open at about 25 percent above the maximum normal operating pressure.

If this procedure fails to clean the valve, the power unit driving the pump should be stopped, the valve cover removed and the operating piston and spring taken out so that the inside of the valve can be cleaned. The piston should move freely up and down in its cylinder.

In checking relief valves, look for scored or worn parts. A valve spring may be broken. The pressure control ball of the Vickers balanced relief valve can be reached by opening the pilot valve, removing the washer, oil seal and gasket, and taking out the spring and ball with a magnetized rod. In disassembly, it is important to note the order in which different parts have been removed.

The next installment will cover pressure reducing valves. Be sure to save all installments for future reference.

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RAISING TWELVE MILLION POUNDS

(Continued from page 13)

by instructions and controls from the director with his microphone and gauges on the deck of the bridge.

Lifts were made slightly over 6 inches at a time, after grillages of 6 in steel I-beams were inserted under all bearings columns and the bridge was dropped back on the grillages. Then jacking boxes were unbolted at the bottom, fluid in the jacks was reversed, the jacks hoisted themselves upward to allow insertion of 6 in I-beams beneath them preparatory to a new lift.

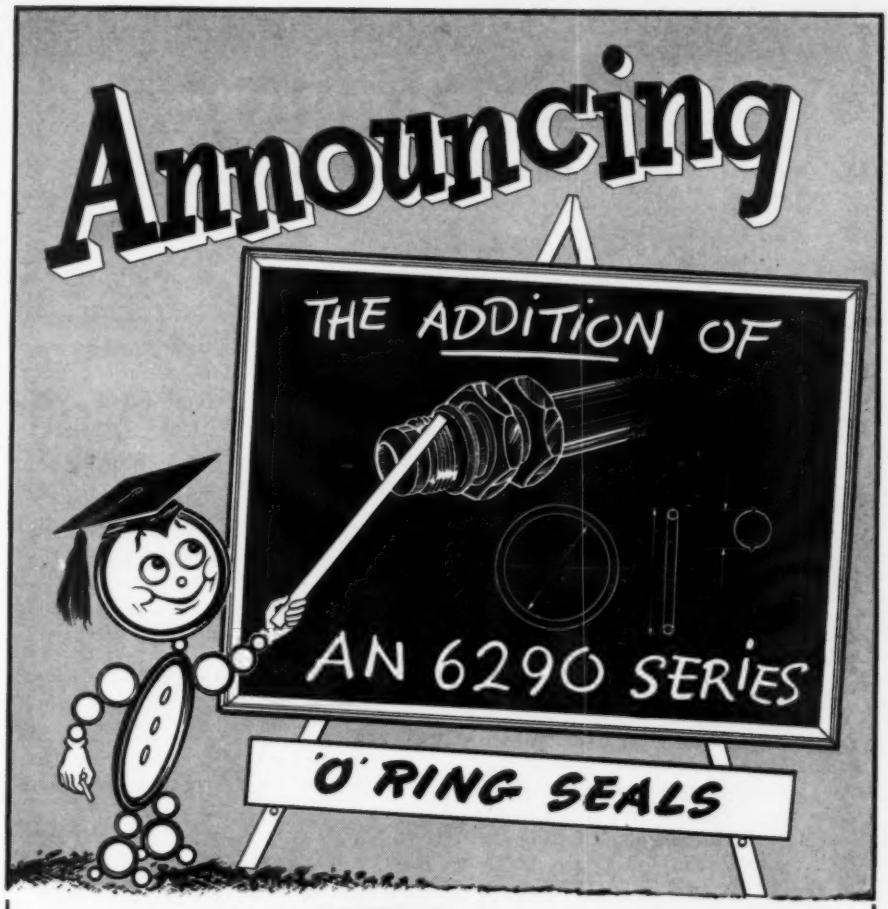
When the steel grillages were built up to a height of 2½ feet, pouring of concrete to build up the 86-foot wide piers was started; the grillages were left to be sealed into the new sections of the piers. A special mix of concrete was used to permit quick bearing of the bridge load.

This process of lifting and inserting I-beam grillages every 6 inches for 2½ feet and building up the concrete piers, was repeated until the job was completed with a total lift of 7½ feet. Grillages for the full height totaled 133,000 pounds of beams, while 800 cubic yards of concrete were necessary to build up the piers.

Once the operation started it could not stop and the five days and nights all ran together with very little sleep for any of the principals concerned. Hydraulic lines were replaced on the spot, spare hoses were put in place, jacks were repacked when concrete was being poured and pumps were repaired in the middle of the night.

The operation ran like clock-work under the able guidance of Carlos Tavares, a bridge engineer of world-wide reputation. Mr. Tavares, in addition to several deep water bridges in China, won renown for raising the Bridge of the Gods over the Columbia River at Cascade Locks, Oregon, 47 feet above the original elevation when the Bonneville Dam was constructed.

With the successful completion of the lift job and the restoration of rail transportation to Terminal Island on schedule, the Henry Ford Avenue bridge is now accommodating vehicular travel and Cerritos Channel is open to ship traffic.



– another GRC precision seal presented by MR. G.R. O'RING!

Developed

- for leak-proof hydraulic and pneumatic gasket sealing of standard AND10056 and AND10057 straight thread tube fittings in AND10050 bosses.

Complying

- with specifications MIL-G-5510 (AN-G-35) and AN6290 in material, dimension and finish requirements.

Available

- from our approved compound No. 1104 in the complete size range standardized for AN6290 series gaskets.

• • • • • •

For full data and prices on these top-quality AN6290 "O" ring seals, request our bulletin No. P-112.

You'll also value a copy of "O" ring catalog "C". Ask for it too—it's free.

As convenient as your own stockroom!

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1565 Oakman Boulevard
Detroit 6, Michigan
Phone Townsend 8-4088

Machell Rubber & Supply Co.
1230 North 12th Street,
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Phone Franklin 2-0560

Standard Parts & Equipment Co.
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Goshen Rubber AND MANUFACTURING CO., INC.
MOLDED RUBBER SPECIALTIES. WASHERS

QUALITY MECHANICAL RUBBER GOODS FOR 34 YEARS

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New PRODUCTS

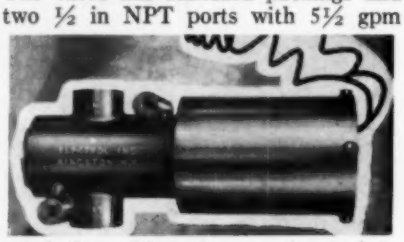
For additional information on any of these products, mark the end key numbers on the card bound in this issue and mail the card.

Portable Intensifier

The Cooper-Bessemer Corp. is now making available a simple setup for static pressure testing of piping systems, compressor cylinders and similar pressure vessels. Developing up to 23,000 psi, the new device is suitable also for laboratory destruction tests. The intensifier is compact and weighs 80 lbs. Operation requires only the connection to any ordinary compressed air line, and any static pressure of 90 psi can be quickly built up to 23,000 psi. *1.*

Poppet-Type Solenoid Valve

Now being offered by Electrol Incorporated, is a new two-way, DC, poppet-type solenoid valve for use in applications where heavy-duty, constant service is required. Available either normally open or closed, they can be used in oil, water or air up to 1500 psi with a solenoid range from 6 to 220 volts DC. The valve has standard packings and two ½ in NPT ports with 5½ gpm



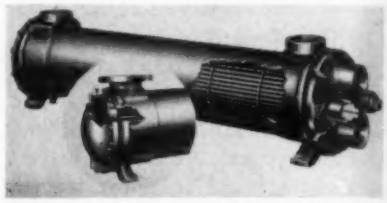
rated flow. Mounting requires ¼ in bolts. *2.*

High Pressure Seal

An improved high pressure seal, designed to meet the extraordinary sealing requirements of equipment handling hydrocarbons under high pressures and temperatures is announced by Felt Products Mfg. Co., Packing Division. The new type H-P seal has three major improvements; control and balance, reducing sealing face wear; fewer parts to wear and maintain; a new simplified cooling method, eliminating auxiliary cooling systems. A variety of liquids up to 600 psi and 250 F in centrifugal pumps and other equipment can be sealed. *3.*

Removable Bundle Exchanger

Ross Heater & Mfg. Co. is now in production on a new line of standardized exchangers featuring all-cuprous,



removable tube bundle construction. Designated Type BCP, the line is available in a broad range of sizes, 18¾ x 7 in to 79 x 10 in overall, single or two-pass types. The design requires no special fabrication at installation point and replacement parts are carried in stock. *4.*

High Pressure Lubricator

A new portable, high pressure Centro-Matic Bucket pump, Model 1808 lubricator, for single line systems has been announced by Lincoln Engineering Co. The unit has 30 lb capacity and is designed for injector circuits installed on machines not equipped with pumps or not in a central lubricating system. *5.*

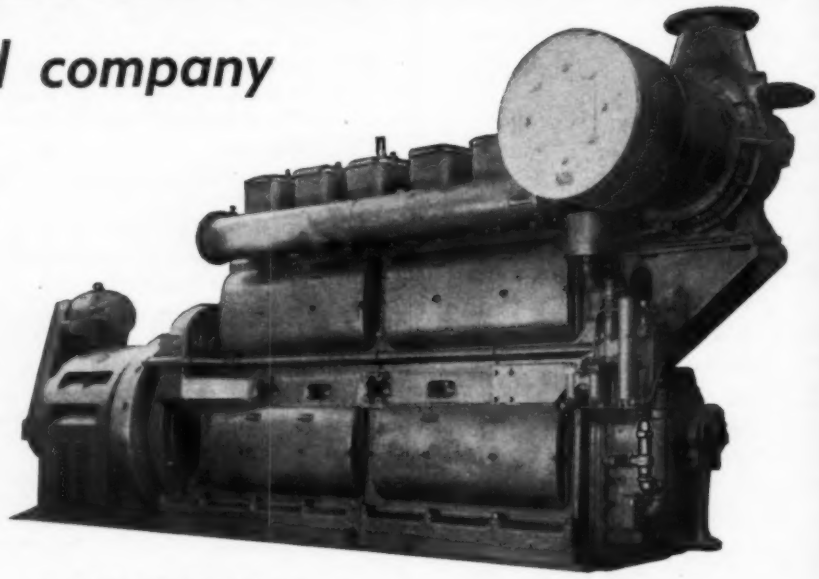
In distinguished company

TRADE MARK FULFLO REG. U. S. PAT. OFF.

RELIEF VALVES on a 955 H.P. Diesel Engine

A distinguished locomotive maker uses Fulflo 1½" IPS piston type pressure relief valves to regulate lubricating oil pressures at 35 pounds per sq. in. for lubricating bearings.

"Fulflo Valves are sometimes seen . . . never heard."



The **FULFLO VALVE** shown on this photograph is made with brass body and stainless steel pistons.

Consult the Fulflo technical staff on your problems.

TRADE MARK FULFLO REG. U. S. PAT. OFF. **Specialties Co., Inc.** BLANCHESTER, OHIO

Write on your letterhead for the

FULFLO MECHANICAL DATA BOOK.

Cylinders With Double Size Rods

A new line of Gerotor hydraulic cylinders, with piston rods twice the standard diameter are being produced by Rivett Lathe & Grinder Inc. Suitable for injection moulding machines and hydraulic presses, the new design is known as a 2:1 cylinder. The new rod, being twice in size, reduces by its additional area, the oil displacement within the cylinder and allows retraction at twice the speed of extension. The speed-up shortens the work cycle and saves power by requiring a smaller pump. These new cylinders are available with any of the five standard mountings, 10 bore diameters in any length up to 96 in stroke and with cushioning at either or both ends of the piston rod. *6.*

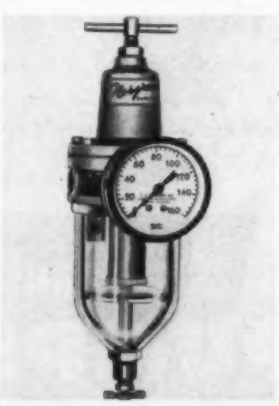
New Time Delay Valve

Production of a time delay valve which operates on an entirely new principle of air control, has been announced by Ross Operating Valve Company. The new model, unlike the old spring-pressure controlled valves, operates by vol-

ume measurement of air; this assures constant repetition of time sequence. Available for use on all Ross in-line operating bodies, ¼ to 1¼ in size, the valves are furnished in straightway, three-way, normally open or closed models. It is adaptable for jigs, fixtures, machine tools and other time sequence requirements. *7.*

Filter-Regulator Unit

The C. A. Norgren Co. has released their new Series 5A cleaning and regu-



lating unit for air powered pneumatic equipment. The filter-regulator is for

ROPER Rotary PUMPS

DELIVER LUBRICATING OIL ON BALDWIN ROAD-SWITCHING LOCOMOTIVES...150 G.P.M. at 100 P.S.I.

This 1500 HP Diesel Locomotive, built by Baldwin, serves the C & O.

Close-up of the special Roper pump which is located at the front left-hand side of the Diesel Engine. The pump is chain driven.

A TYPICAL "CUSTOM-BUILT" APPLICATION BY ROPER

This custom-built pump — made to deliver lubricating oil on a Baldwin Diesel Switching Locomotive — is typical of a wide range of tailored-to-the-job units produced by Roper. Although applications may vary greatly, each custom pump is designed along the basic Roper principle employing only two moving parts. The simplicity of this design — equal size, helical pumping gears operating in a case with proper clearance — promotes high efficiency and long service life. Roper custom-built — as well as Roper standard models — can effect substantial savings in the long run. Sizes range from 3/4 to 300 G.P.M. — pressures up to 1000 P.S.I.

Send For Descriptive Literature

GEO. D. ROPER CORP.
705 Blackhawk Park Ave.
ROCKFORD, ILLINOIS

ROPER Rotary Pumps

DEPENDABILITY SINCE 1857

use with air and non-corrosive gases up to 125 psi and 120 F ambient and is applicable to production machines, sprayers, instrument control and other industrial air line service. The filter and regulator is a single unit, not an assembly, and is available in two sizes, ¼ and ⅜ in, with six types of regulator springs, the standard being the Hi-Lo spring for 5 to 125 psi. *8.*

Pressure Actuated Switches

Meletron Corporation has just released its new Model 424 "Dualtrol" switch which actuates at any two predetermined pressures. A diaphragm sensing element actuates two SPDT snap-action switching elements at any

two independent pressures. Six classes of switches provide adjustable ranges from 2 in of water to 100 psi with proof pressures up to 120 psi. Housing dimensions are 3 in dia; 4⅛ in overall. Pressure connection to ⅛ in external thread with ½ in conduit connector. The "Dualtrol" has applications for warning signals, maintenance of constant pressures between two limits or for sequence control. *9.*

Safety And Relief Valves

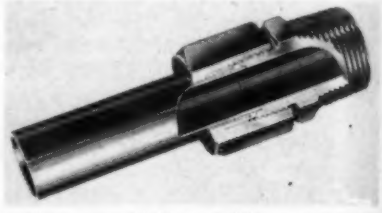
The Kunkle Valve Company has added a complete line of cast carbon and alloy steel safety and relief valves to its bronze line. The new additions were formerly manufactured by Star Brass Co. whose facilities have been purchased by Kunkle. Included in the new line is a ¾ to 6 in cast carbon steel valve, with stainless steel trim, for pressures to 600 psi and temperatures to 650 F. Other valves for air, steam, gases, vapors and liquids are available. *10.*

Bantam Size Control Valves

A. Schrader's Son, Div. of Scovill Mfg. Co., Inc., has released a complete line of small, 2-3-4-way, compact opertaing valves for use with single and double acting cylinders, featuring the sliding disc principal. One steel bolt holds the two-piece body and internal parts in place and contributes to time saving, low cost maintenance. Available for hand, foot, knee or mechanical actuation the valves have ⅛ in ports delivering full line flow. Adaptable for small bore cylinders, they can also be used on cylinders up to 3½ in bore in short strokes. *11.*

Flareless Tube Fittings

A new flareless tube fitting introduced by the Aircraft Fitting Company, eliminates tube gouging and limits tube dis-



tortion, permitting quick, economical installation. The gripping action of the fitting sleeve forms a positive leakproof seal and makes for suitable copper, steel, stainless steel and aluminum applications. It is available in all standard shapes and sizes for tubing up to 1 in in OD. The AFCO fitting meets all requirements of JIC Hydraulic Standards as well as spec AN-F-47. *12.*

Three-Way Pneumatic Control

Johns Engineering Co. announces a new Three-way, ⅜ in pneumatic valve for control of pressures and vacuums. The outlet connection is on the bottom face with inlet and exhaust ports at opposite ends. The valve is of the plunger type, ⅜ in dia, 6 in overall, made of anodized aluminum with chrome-plated steel plunger. Sealing members are rubber lined. *13.*

if it can use hydraulics

Wherever mechanical motion is required, there's a possibility of using Hydraulics to advantage—for economy, speed, smoothness, or greater operating efficiency.

HUFFORD, one of the Pacific Coast's leading exponents and builders of Hydraulic Equipment, can help you. For engineering recommendations and estimates, *call on us.*

HUFFORD MACHINE WORKS, INC.
Redondo Beach, Calif.

Builders of the famous Hufford Hydraulic Stretch-Wrap Forming Machines, Hydraulic Ceramic Presses, Hydraulic Elevators, and Specialized Hydraulic Machinery.

HUFFORD HYDRAULICS

Know all the answers

. . . before you buy hydraulic pumps! A Gerotor check-list will help you to pin down your requirements . . . specify and buy more intelligently. Copies are yours for the asking . . . no obligation.

GEROTOR hydraulic PUMPS

GEROTOR MAY CORPORATION, Baltimore 3, Md.

Useful Literature

The publications listed are available without charge. Mark the initial key number on the card bound in this issue and mail.

28. Air Cylinders . . . The new 16-page, two-color, Catalog Section No. 54 just published by Rivett Lathe & Grinder, Inc., describes and illustrates the entire line of Gerotor air cylinders. Drawings and tables are furnished for each model and size cylinder with valve recommendations to help the engineer with circuit layouts. Rabbet, foot, trunnion, center-line, blind end flange, rod end flange and clevis types of mountings are detailed. Features of Gerotor double acting, non-rotating air cylinders include keeper-ring construction which permits a more compact design and allows convenience in locating pipe connections, self adjusting composition rod and cup packings to eliminate hand service.

29. Remote Controls . . . Pneumatic remote controls are the subject of a 12-page illustrated Bulletin No. 645 published by The Tomkins-Johnson Co. Remote controls can be applied to presses and other machines for pneumatic push button operation to safeguard workers and reduce manual effort. The primary units shown are the master valves, 30 to 100 psi working pressures, that control the application of compressed air to the cylinders and pilot valves ⅛ in IPS, ¼ or 5/16 in OD that control the masters. Pilot valves are available in designs for simple or complex controls, hand, foot or mechanical operation, singly or in multiple for locations in any desired position.

30. Needle Valves . . . The Hoke Incorporated 20-page catalog contains information and data on needle valves, pressure reducing valves, gauges and controls. Standard stock lists the blunt and V point valves, pressure tested to 2,000 psi, available for use with all kinds of gases, with water, compressed air and vacuums; sizes ⅛ to ¼ NPT. Corrosion resistant needle valves are obtainable in all sizes up to ½ in made from stainless steel with hardened stainless steel or Hastelloy "C" heat treated, inset spindle points. Monel needle valves have heat treated Z-nickel spindle with ground point. High and low pressure reducing valves, adapters, special purpose and toggle valves along with flo-gages and pressure containers are also described.

31. Hydraulic Oil Cylinders . . . Bulletin 49-55 shows a wide variety of styles and sizes of Vickers Incorporated, hydraulic oil cylinders. Design features of each type are illustrated with specifications and dimensional drawings. The 28-page bulletin includes engineering data on the use and selection of cylinders, flow calculations and types of oil circuits.

CIRCLE NUMBERS ON THE CARD AND MAIL!

32. Electric Valves . . . Skinner Electric Valve Division of the Skinner Chuck Co. has released a descriptive bulletin No. 494 on their two-way pilot operated, normally closed, solenoid valve. The Model M2 with a 10 watt operating maximum is satisfactory for use with petroleum ,oils, water, air and inert gases over a pressure range of 5 to 150 psi. Applications include industrial machinery, process equipment, air vises, air and hydraulic cylinders.

33. Small Air Compressors . . . Worthington Pump and Machinery Corp.'s 16-page Bulletin H-620-B30 gives descriptive data on air-cooled

PEMACO — HYDRAULIC and AIR CYLINDERS

the last word in design and operation

AMPLE BRONZE BEARING

INTERNAL SNAP TYPE KEEPER RING

PRECISION HONED STEEL TUBING

NEW TYPE, LOW FRICTION PISTON SEAL—EFFICIENT & UNEXCELLED FOR DURABILITY

"O" RING SEALS

NEW TYPE, LOW FRICTION RAM SEAL—EFFICIENT AND UNEXCELLED FOR DURABILITY

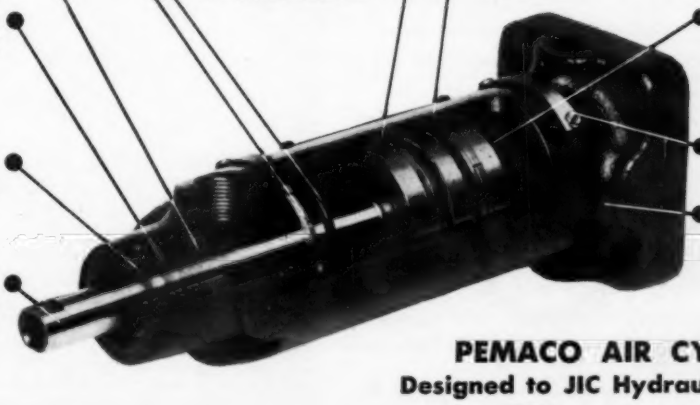
PISTON AND RAM POSITIVELY SECURED BY PATENTED LOCK NUT

"SEAL GUARD" RAM SCRAPER POSITIVE PACKING PROTECTION

BRONZE COVER PLATE

"HEAVY DUTY" HI-TENSILE CAST IRON CASTINGS

50 ROCKWELL—HARDENED AND GROUND STEEL RAM—SCORE RESISTANT



PEMACO AIR CYLINDER
Designed to JIC Hydraulic Standards

An exclusive feature is the one piece piston construction. Other makes using synthetic or leather cups usually have a piston made of three pieces...and thus cannot maintain 100% concentricity.

Send for full details on both *AIR* and *HYDRAULIC* cylinders.

PETCH MANUFACTURING COMPANY

2769-71 HARPER STREET
MT. CLEMENS
MICHIGAN

compressors and dry vacuum pumps, ¼ to 20 hp, 40 to 250 psi, single or two-stage. Illustrations and specifications are listed for both bare and mounted types with standard and optional equipment and accessories necessary for each installation. A series of cross section drawings illustrate the features of the Feather Valve and the construction of the compressors. A utility cart-mounted compressor and single and two-stage vacuum pumps are also illustrated along with air receivers and valve accessories.

34. Air Cylinders . . . Ledeen Manufacturing Co. announces a 12-page catalog, Bulletin No. 500, which includes information on the recently announced medium duty cylinders. Dimensions and weights, ratings and limitations are also given for the heavy duty and super duty lines. A method of cylinder selection is included along with illustrations and designs of rod and head attachments for the complete lines of cylinders available.

35. Small Pumps . . . Tuthill Pump Co. has issued a descriptive 4-page bulletin, with drawings, on their Model L series of small industrial pumps. These pumps supplement the Model CK series. Tuthill pumps have various industrial uses such as lifting shafts of heavy machinery, metering fuel oil, operating chucks and as boosters on large flow lines. Model L pumps operate on the "internal gear" principle and have a capacity range of ⅛ to 3 gpm in five sizes for operating pressures up to 400 psi. Either ring or foot mounted they all feature the Tuthill mechanical seal.

36. Valve-Sizing Charts . . . Liquid and gas valve-sizing charts covering the ranges 0.02 to 10,000 gpm and 1 to 100,000 lb per hr respectively, have just been published on heavy stock by Fischer and Porter Company. The charts take into account the differences between pressure drop across the valve and across the valve ports alone, liquid viscosity and specific gravity in determining port area and valve size. Inlet and outlet absolute pressures, gas specific gravity and temperature are also charted.

37. Power Pumps . . . Four types of industrial pumps with many applications illustrations are shown in the 30-page two-color catalog published by the John Bean Division of Food Machinery and Chemical Corporation. Multiplex power ends, duplex pumps, inside and outside packed triplex pumps are detailed with drawings and charts, showing capacities from 1 to 80 gpm and range 100 to 6,000 psi. Applications include sterilizers, pressure cleaners, process machines, circulators, sprayers in the food, mining, chemical and steel industries. All pumps have special self expanding piston cups, anti-friction ball bearings and the company's own eccentric drive. Pump accessories, spray guns and nozzles are also shown.

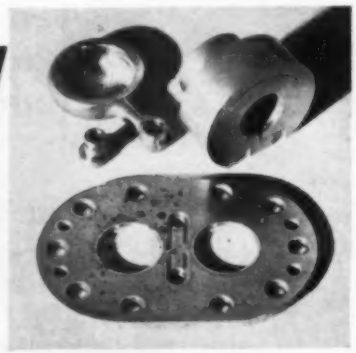
38. Rotary Actuators . . . Bulletin EM 200-3-39 depicts Series 186, 188 and 189 rotary actuators produced by Lear Incorporated for aircraft and industrial applications. Applications include valve control with remote indication, material handling equipment and throttle control of large power sources.

39. Operating Mechanisms . . . Royal Electric Manufacturing Co., Inc., shows in its 6-page bulletin a hydraulic switch operating mechanism for remote control or automatic operation of heavy circuit breakers. Type JH for manual and JHM for motor operated consist mainly of a double acting cylinder which is the power unit, tubing and a slave or operating cylinder. The mechanism has solenoid operated valves and can be used in or outdoors.

40. Miniature Multi-Pole DC Relay . . . A 4-page, two-color, bulletin published by Struthers-Dunn, Inc., shows their new miniature multi-pole DC relay that is built to withstand 15 G's vibration or 25 G's shock while operating. Two hermetically sealed and two open types are available in operating ranges from 2/3 to 1 1/3 nominal voltage with power requirements as low as 1 watt up to 3 watts.

41. Rotary Pumps . . . An 8-page Bulletin 50-S, published by Viking Pump Co., illustrates their entire line of rotary pumps and indexes the literature available for each model. The

BETTER BRONZE PARTS FOR ALL TYPES OF PUMPS



American Crucible methods, know-how, experience and equipment result in highest quality parts at attractive savings to you.

Thrust plates, bearing plates, pressure plates, bushings, seals and connecting rods, machined or rough cast from

PROMET THE Engineered BRONZE

of the specific formula best suited to each application. That's why they carry a

MONEY-BACK GUARANTEE OF LONGER SERVICE—LOWER MAINTENANCE COST.

PROMET BRONZE BAR STOCK

Round, solid or tubular. Rough cast or fully machined. Cored stock all sizes (by ⅛" steps) from ½" minimum core to 26" O.D. and 13" lengths or less. Six grades of hardness.

Write for literature or let us make recommendations and quote you. Simply send blueprints, conditions of operation and other data.

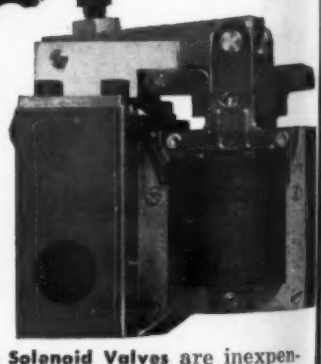
THE AMERICAN CRUCIBLE PRODUCTS CO.
1303 Oberlin Avenue • Lorain, Ohio

NEW HIGH PRESSURE SOLENOID VALVES

FOR 110-VOLT 60 CYCLE A.C. CURRENT

Features

- Rugged compact construction
- 3000 P.S.I. operating pressure
- Continuous duty
- Poppet design eliminates leakage
- May be mounted in any position
- Impregnated coils resist moisture and condensation



Waterman High Pressure Solenoid Valves are inexpensive, compact units designed for continuous duty in hydraulic systems where pressures are as high as 3000 P.S.I. Poppet type construction gives positive sealing against internal leakage. Impregnated oil resistant coils make these valves suitable for mounting in oil reservoirs. In many cases this feature eliminates costly piping and makes possible the construction of smaller, more compact hydraulic power units. Available in ⅜" pipe size. Electrical requirements are 110 volt—60 cycle A.C. current.

West Coast: H. E. Webb, 918 No. Kenilworth Ave., Glendale 2, Calif.

WATERMAN ENGINEERING Company
721 CUSTER AVENUE • EVANSTON, ILLINOIS

construction features, applications, and installation recommendations are given. Standard pumps, ⅔ to 1050 gpm, 50 to 200 psi, have either right or left hand port connections and can be belt or motor driven. Special application pumps include hydraulic pumps for actuation movements on road machinery, machine tools, tractors and lifts. These units are available with opposite ports in capacities 5 to 45 gpm and 50 to 200 psi.

42. Self-locking Nuts . . . Standard Pressed Steel Company's 16-page two-color catalog No. 619-A gives complete descriptive information and technical data on Flexloc self-locking nuts. Carrying capacity, uniformity of torque along with a Catechism of Flexloc are featured in addition to an explanation of the Flexloc Specification Code. Aircraft, commercial and machine type nuts are available. Regular or thin heights are available with National Fine or Coarse Threads in a wide range of sizes.

43. Air-Operated Controllers . . . The Bristol Company has published a 32-page Bulletin No. A120 describing the new Series 500 air-operated Controllers for automatic regulation. Applications include temperature, pressure, flow liquid level, humidity and pH value control. Complete data with pictures is given on on-off, proportional, reset, derivative and reset plus derivative models. Illustrations show in detail the complete features of the new Series controllers.

44. Seal Catalog . . . Double Seal Ring Company describes their One-Piece Double Seal rings in their 8-page catalog No. 1 & M 101. Plain and ported double seal rings, combination rings, ventilated and plain rings and oil scraper rings are shown. Sketches showing typical applications to diesel, gas and steam engines, compressors and pumps and data on clearances in fitting rings are included.

45. Timers . . . Eagle Signal Corporation released a 4-page Bulletin No. 340 covering their complete line of timers and counters. In addition to showing products, Bulletin 340 indexes the individual bulletins available on each timer and counter. The Eagle Timers shown are suitable for a broad variety of industrial control needs. The Microflex counters shown operate on impulses of an electric eye and control by counting instead of timing. A list of representatives is also given.

46. Motor Controls . . . The 4th edition of their handy catalog on modern motor controls has just been issued by Allen-Bradley Co. The catalog highlights 59 individual bulletins and includes information on the selection of equipment. In the 76 pages are condensed information, dimensions and prices of the AC and DC switches, contactors, starters and accessories. Heater element information along with conductor size and overcurrent protection tables are included in the catalog.

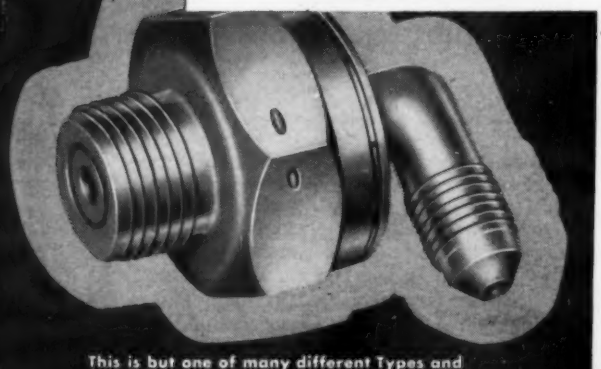
47. Names of Valve Parts . . . The Cooper Alloy Foundry Company announces the publication of a new bulletin, Names of Valve Parts. Diagrammatic sketches of gate, globe, check and lever operated valves are presented with a material and parts identification list. This is one of the first publications of its type to follow the proposed standard designations of the Manufacturers' Standardization Committee.

CIRCLE NUMBERS ON THE CARD AND MAIL!

48. Wire Code Markers . . . An easy method of wire and small pipe and tubing marking and coding is discussed in Bulletin 349 issued by the Western Lithograph Company on their line of E-Z code wire markers. The markers are furnished in paper-backed strips from which individual numbers or code markings may be easily stripped. Markers for 34 standard codes are available. The markers conform to ASA standards.

49. Tube Cleaners . . . Thomas C. Wilson Inc. has published bulletin 47-A on tube cleaners for power plants, refineries and steam boilers. The air, water, and steam motor type cleaners with accessories as cutter heads and expanding brushes are shown. Diameters ¼ to 2 in (ID) can be accommodated. The Wilson Trigger power cleaner weighs 16 lbs while the Pistolgrip power cleaner only 3 lbs.

CHIKSAN
HYDRAULIC SWIVEL JOINTS



This is but one of many different Types and Styles of CHIKSAN Hydraulic Swivel Joints for application on all hydraulic lines which must turn or swivel. Pressure capacities range from 1000 psi. to 3000 psi. Write for Bulletin A. Or tell us your requirements and CHIKSAN Engineers will gladly cooperate with you in developing Hydraulic Swivel Joints to meet your requirements.

CHIKSAN COMPANY
AND SUBSIDIARY COMPANIES
Chicago 3, Ill. BREA, CALIFORNIA Newark 2, N. J.
WELL EQUIPMENT MFG. CORP. HOUSTON 1, TEXAS
CHIKSAN EXPORT CO. BREA, CALIFORNIA NEWARK 2, N. J.

BALL-BEARING SWIVEL JOINTS FOR ALL PURPOSES

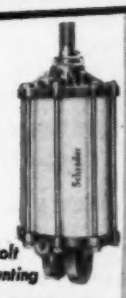
Make Hard Work EASY
with these
BRAWNY NEW AIR CYLINDERS

What's your problem? Operating press brakes, clutches, doors, clamping work, lifting or lowering, pushing or pulling heavy loads?

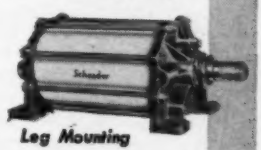
Investigate the time-saving, work-saving advantages of the new Schrader Air Cylinders. See how they do hard jobs faster, safer, better.

See what Schrader has done to make this new series of air cylinders tops for ruggedness, for fast cycle operation, and ease of mounting. See how interchangeability of the parts cuts down maintenance.

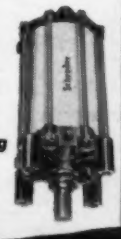
Schrader Air Cylinders are made in Single Acting and Double Acting types; in sizes from 1" to 8" bore; and in any stroke.



Bolt Mounting



Leg Mounting



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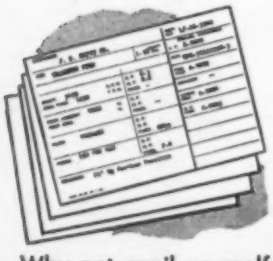

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HERE'S HOW

(Continued from page 18)

On the return stroke the piston follows the ram or male die upward to the end of the power stroke; the ram continues to move up to open the die for ejection of the work piece. The only air consumed is the negligible leakage around the packings.

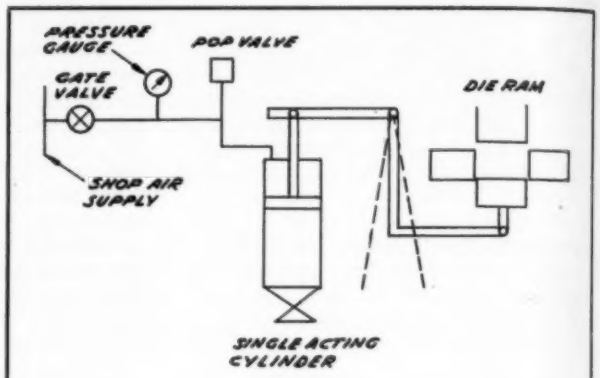

Fig. 1.

This arrangement, unlike a spring, exerts the same force against the work at any portion of the stroke.

Should it be desirable to have an increasing force with the stroke, it can be accomplished by inserting a check valve in the air supply line and using only a part of the stroke. For example, if half the stroke is used, the pressure and consequently the force will be doubled. In such cases, be certain that the cylinder is designed for this higher pressure. The safety or pop valve *must* be set for a safe operating pressure. Figure 2 shows such an arrangement schematically.

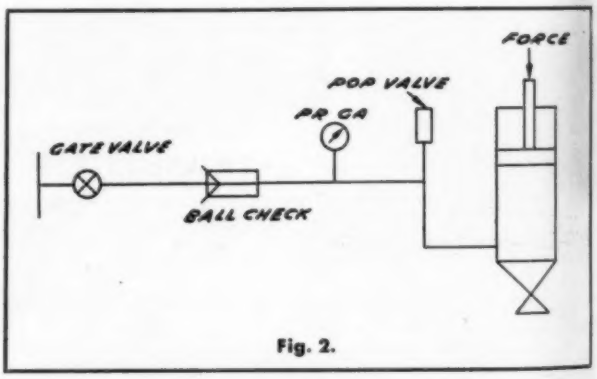

Fig. 2.

The same suggestion may be employed to hold a follower against a cam. Dead weight is often used for this service. The cylinder does the job with less bulk and, in many cases, with less strain on the machine. The cylinder may also be connected with a three-way valve and relieve the operator of the load of moving the weight around on the idle part of the stroke. Figure 3 shows a three-way valve in the supply line. This setup may be used in applications where dead weights entail a space problem (operator's convenience in loading and unloading the machine, delivery and take-away conveyors, stock boxes, etc.) and where the strain of dead weights on operating parts of a machine necessitates frequent setup attention.

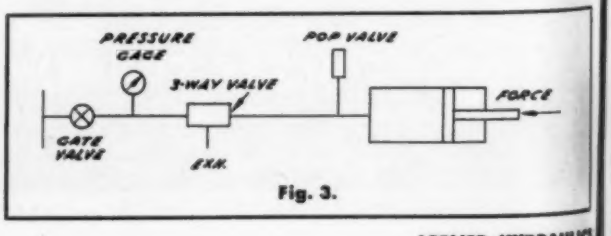

Fig. 3.

The methods suggested use very little air, being based on the assumption that a cylinder can be selected to permit it to float on the line. Where it is desirable to set up a variable pressure in the cylinder, a pressure regulator may be put in the line. Since air can flow through a regulator in one direction only, it is necessary to have a continuous bleed that discharges air faster than the cylinder generates it on its counterstroke. The setup is shown in Figure 4. In some cases the bleed valve may be closed and the safety valve set to pop slightly above the pressure regulator.

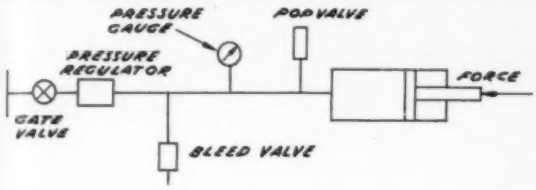

Fig. 4.

It is important that the safety valve be directly connected to the cylinder. Otherwise, if the cylinder operated faster than the lines can absorb the air or if the gate valve is closed inadvertently, excessive pressures in the cylinder may be developed.

These are just a few of the possible combinations where this type of control is applicable.

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BOOK REVIEWS

Fluid Pressure Mechanisms

H. G. Conway, *M.A., A.M.I.Mech.E., F.R.Ae.S., Chief Engineer Messier, Ltd., 218 pages, 5½ x 8⅜ inches. Published by Pitman Publishing Corporation, New York, $5.00.*

This book could best be described as a summary of the state of the art as applied to hydraulic mechanisms and their uses. Approximately 500 illustrations are used to show the various types of devices currently being used, together with representative basic systems in which they are employed. The list includes basic valve elements, pumps, receiving units, pressure and flow control valves, and other miscellaneous and unclassified items. The system coverage includes elementary power systems through such complex types as remote control and servo equipment. The author has not tried to delve into the advantages and shortcomings of each item illustrated, but has offered such descriptions and pertinent comments as were available to him. It is to the author's credit alone that he was able to assemble and illustrate in a simple schematic manner the many and varied types of equipment which the work includes. Engineers and designers will find this book extremely valuable for reference purposes and in the design of new equipment while others will find much basic knowledge of the functioning of hydraulic mechanisms explained in a simple and understandable manner.

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Physical Properties of Lubricants

American Society of Lubrication Engineers, *Educational Committee, Professor D. D. Fuller, Chairman; 72 pages, 5½ x 8 inches. Published by The American Society of Lubrication Engineers, at $1.00.*

This booklet, the first of a series on various phases of lubricants and lubrication, presents a discussion on nine of the commonly used physical characteristics of lubricants. The text is prepared to provide information to readers without an advanced technical education. However, a bibliography is included, which may be used by those desiring a more rigorous background. The properties discussed are viscosity, gravity, cloud and pour points, flash and fire points, carbon residue, neutralization number and interfacial tension, saponification number, emulsification and specific heat. Although two of these may be considered chemical properties, emphasis is placed on their physical significance.

The booklet is of particular value to maintenance personnel, laboratory technicians and all students of chemical and mechanical engineering.

Practical Aircraft Hydraulics

Earl J. Horrell, *maintenance mechanic and supervisor, Continental Air Lines, 46 pages, 8½ x 11 inches, plus 54 pages of colored illustrations. Published by The World Press, Inc., Denver, Colorado, at $3.85.*

As the preface indicates, this book has been written for the mechanic by a mechanic. It is thus the type of book which will be of most value to the airline maintenance mechanic or others performing similar work. The book gives an introductory chapter on basic hydraulics but illustrates them in the way these principles are actually applied in aircraft equipment. The following chapters are devoted to a complete description of the DC-3 hydraulic system and equipment, but at the same time points out the important hydraulic principles involved in each case. The author also asks a number of questions regarding each chapter in order to stimulate the reader's thoughts as he goes along. Methods to be used for trouble shooting the more common difficulties are given in connection with the various equipment items and for the system as a whole. Also included are brief descriptions of the DC-4 and DC-6 hydraulic systems. The Constellation and Convair 240 systems are covered by a drawing of the schematic diagram and a few additional remarks. F.O.H.

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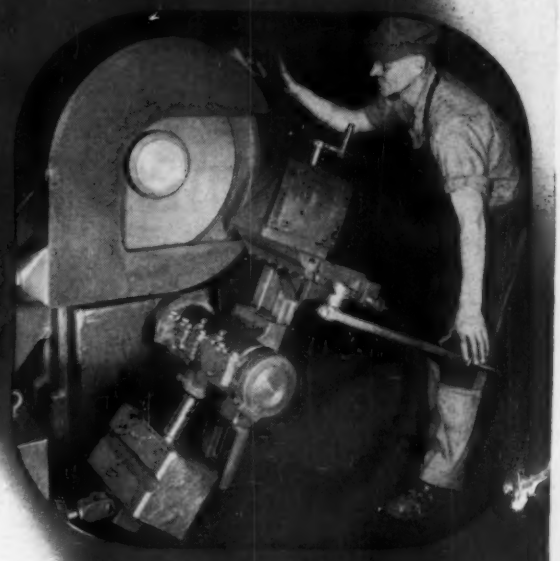

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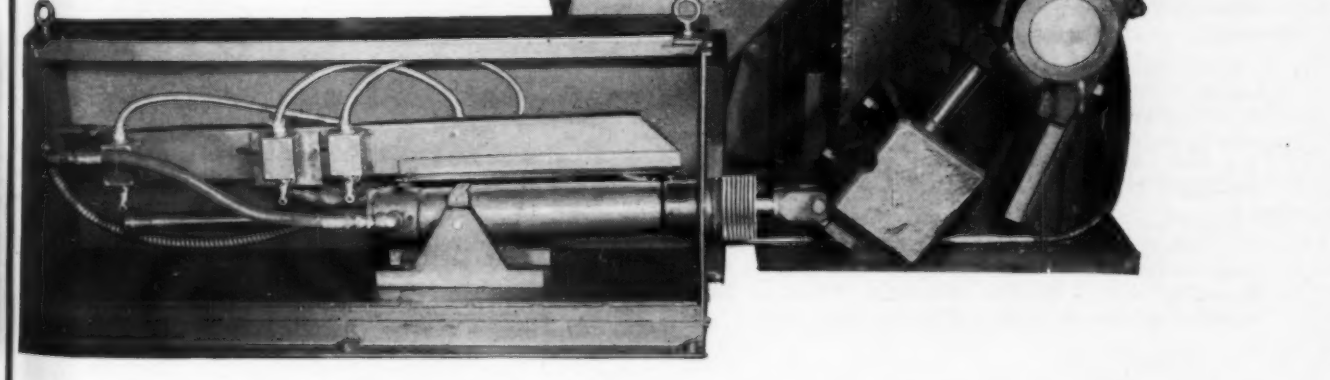

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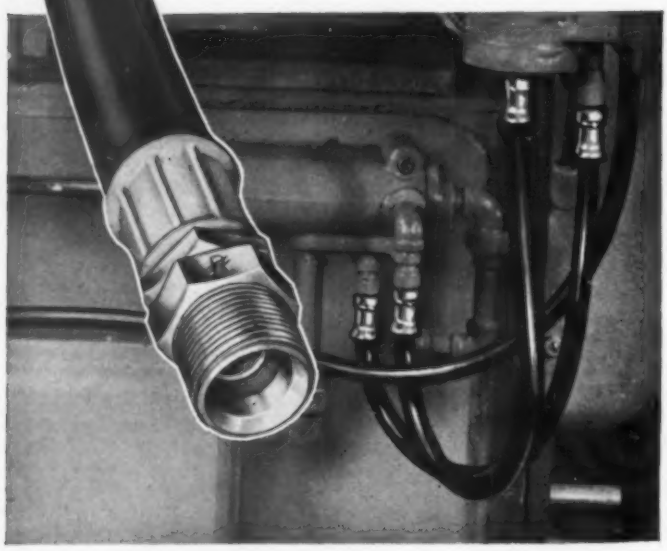

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Characteristics Of Some Magnetic-Fluid Clutch Servomechanisms

From a paper by **A. J. Parziale** and **P. D. Tilton** (American Institute of Electric Engineers, No. 50-24).

After stating that systems using magnetic-fluid clutch servomotors follow normal servomechanism design practice and compensation techniques and that the speed of response of a given clutch depends on its size and design, several limitations are pointed out: (1) the ability of iron-oil mixtures to withstand high temperatures for long periods and the fluid properties to prevent packing and settling out of the iron powder during inactivity must still be improved; (2) special seals must be provided, face-type seals with graphite elements have been found superior to conventional shaft or bearing seals in magnetic clutches; (3) the high

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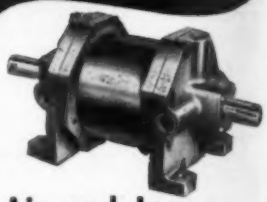

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temperature properties of the insulation and seals limit the allowable temperature rise, since clutches, like other servomotors, must dissipate heat generated by working against stall load torques; and (4) the winding insulation must be protected from high transient voltages, high temperature and abrasion. The magnetic-fluid clutch is also adaptable to brakes, dynamometers, spring or damping simulators and general purpose torque loading devices.

Hydraulically Operated Double-Draw Die

L. D. Richards, *Machinery*, v 56, January 1950, pp 185-186.

The use of an auxiliary, portable, hydraulic unit to act as a hold-down in single action type of press for a draw and redraw is described. Both functions are performed in one operation, an air cushion with an unusually long stroke being used to permit the down stroke to continue after the first draw is completed. The material drawn is 52S-O aluminum, 0.32 in thick, fed to the press in coils and drawn into shells to a depth of 3⅜ in, with an outside diameter of 2 inches. A diagram and a detailed description of the operation are included.

Simplified Design Calculations For Positive Displacement Hydraulic Pumps

R. W. Bowman, *Machinery (English)*, v 76, January 19, 1950, pp 87, 88.

The author presents a method of establishing essential dimensions of suction and delivery valves without using velocity and acceleration diagrams.

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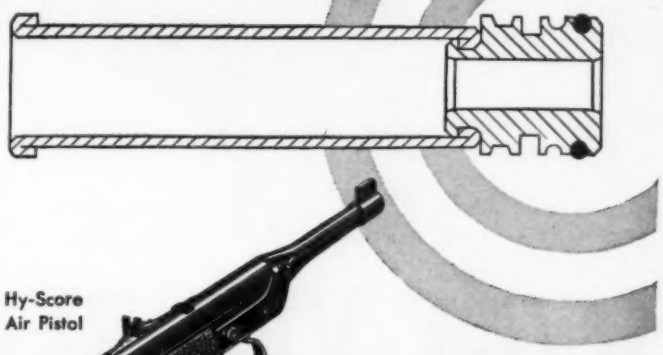

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POST SCRIPTS OF INDUSTRY

NEWS · VIEWS · TRENDS

William F. MacDonald was elected president of E. F. Houghton & Co. at the February stockholders meeting succeeding Maj. Aaron E. Carpenter who voluntarily relinquished the presidency when elected chairman of the board at the same meeting. W. F. MacDonald has been associated with the company since 1927 and has served in various capacities.

George B. Miller, chief engineer, Hydraulic Div., Racine Tool & Machine Co., spoke on the types of oils available to the hydraulic industry, their advantages and disadvantages at a meeting of the Racine chapter, ASTE. Members from Racine, Kenosha and Milwaukee were present at the meeting held in the Racine Manufacturers Building.

In a recent announcement H. H. Reynolds was appointed manager of the Los Angeles office for De Laval Steam Turbine Co. and J. Horth named manager of the St. Louis office.

Colby M. Chester was elected chairman of the board and Robert R. Watson re-elected president of Manning, Maxwell & Moore, Inc. Mr. Chester replaces the late C. A. Moore, and has been on the board of directors for the last 20 years.

J. C. Poole was promoted to director of purchases for Hydraulic Press Mfg. Co. He has been associated with the company for many years and was formerly assistant purchasing agent.

The Weatherhead Company of Canada, Ltd., at St. Thomas, Ontario, is presently producing approximately 65,000 bent tube units a week for scores of Canadian manufacturers as a result of a new specialized bending operation based on designs by H. A. White, the company's chief design engineer.

The R. P. Adams Company announce the appointment of Machinery & Equipment Sales, Inc., 1014 Cathedral Street, Baltimore, as their exclusive representative in the State of Maryland.

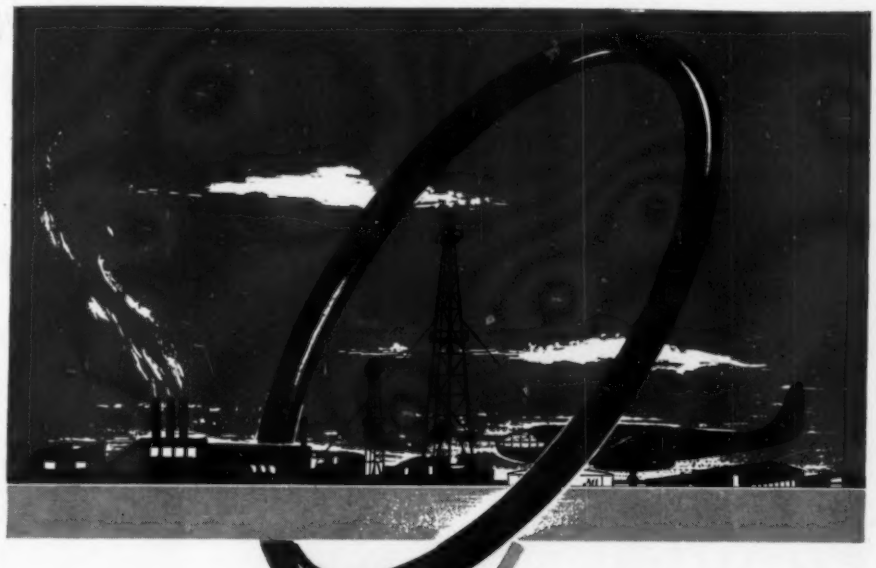
The Paquin Co., Cleveland, Ohio, has recently been appointed exclusive representative for Greer Hydraulics, Inc., in the Northern Ohio district.

G. F. Maughmer, formerly manager of General Electric's sales office in Los Angeles, has been named manager of G-E's new 12th district apparatus sales department with headquarters in St. Louis.

Fred R. Paris, who for ten years was with Worthington Pump and Machinery Corporation, Harrison, New Jersey, has been appointed district representative for Marlow Pumps, Ridgewood, New Jersey. Working out of the firm's home office in Ridgewood, he will be in charge of industrial pump sales for New York State and part of Canada.

Mr. Paris

Dorr-Patterson Engineering Co. have moved to 241 Chene Street, Detroit 7, Mich.



"O" RINGS SINCE 1941

Outstanding by nature—Parco Balanced Compounds + precision moulding make the outstanding hydraulic packing. For "O" ring packing, investigate "O" rings from Parco Balanced Compounds. All dash numbers of both 6227 and 6230 series for commercial application or Army-Navy installations to Specification ANP 79 are available from stock.

Catalog and engineering data on request. Write us today.

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Plastic & Rubber Products Co.

2100 Hyde Park Blvd., Los Angeles 47, Calif.

919 N. Michigan Ave., Chicago, Ill.

BASIC CHARACTERISTICS

(Continued from page 17)

and speed brakes determined the maximum demand, then the pressurized system would be chosen since this demand could occur anytime during "in flight" operations.

Surface control boost and power surface control systems present many new problems to the designer. First of all the power requirements for these systems have increased rapidly due to increased speed and maneuverability. Here, additional power take-off pads on engines to accommodate these requirements have not been provided. The hydraulic designer is therefore forced to a compromise design in order to provide sufficient power and safety for these systems. The use of electric motor driven pumps has greatly alleviated this condition, but there again sufficient electrical power is not always available and, generally speaking, the use of electric motor driven pumps constitutes a severe weight penalty. The problem of safety and reliability for this type of power source always arises and the designer, in order to overcome this objection, has been forced to provide automatic cross over valves to supply utility system power for the boost systems. This interconnection of utility and boost systems, while not too desirable, appears to be the best present solution to the problem.

It can readily be seen that there are no set rules for proper selection of type and class of hydraulic system, or systems, for all types of aircraft. The designer must consider type of airplane, its missions, duration of flight, "in flight" requirements, and all other detail requirements as well as characteristics of all types and classes of hydraulic systems.

THE MARKET PLACE

CLASSIFIED ADVERTISING

These columns are limited to Help Wanted or Position Wanted ads, and offerings of used equipment by the users of such equipment.

Rates: For "Positions Wanted" $4.00 minimum, limit 25 words. For all other classifications $4.50 minimum for 25 words, each additional word 15c; bold face type or all capitals, $7.50 minimum for 25 words, each additional word 20c; limit 50 words. Box addresses count as five words. All insertions are payable in advance.

ENGINEERING
SALES AND SERVICE
REPRESENTATIVE WANTED

Domestic and foreign travel involved. Young, unmarried, college graduate preferred. Knowledge of Spanish helpful. Must be experienced in hydraulic circuits, design and installation work, especially machine tool and industrial application. Submit full information with photo, also starting salary expected. Address Edwards Engineering Corp. New Orleans 16, La.

Engineering sales representatives wanted in principal cities to handle complete, quality line of air and hydraulic cylinders. Write in confidence, stating lines now being handled, territory covered and references. Address Box 5150 APPLIED HYDRAULICS.

FORGET THE WHOLE THING
—forget this pesky job of manually draining your compressed air lines.
(It's often forgotten, anyway)

SIMPLY INSTALL THE NP Automatic WATER EJECTOR VALVE

Continuously and automatically removes the *collected* water from water separators, air reservoirs, or low points in air lines. Eliminates water damage to equipment, work and materials. Saves labor, expense, worry—and many a shutdown or production slow-down. No air loss! Bulletin DC-25-A tells why. Address NATIONAL PNEUMATIC CO., INC., Industrial Div.
—Graybar Bldg., New York.
—Boston.
—Chicago.

NEW! DIFFERENT!

TWO NEW VALVES FOR *Effortless* CONTROL OF AIR CYLINDERS!

TYPE NH (above)—A new hand-operated, four-way, directional air control valve. Sizes ⅛" and ¼". ⅜" lever motion.

TYPE NF (right)—A new foot-operated, four way, directional air control valve. Sizes ⅛" and ¼". With or without pedal guard.

HERE is the newest thing in air valves for operating single or double acting air cylinders! Built for *hand or foot* operation, these instant-acting valves provide fast, effortless control comparable to an electric valve—*at minimum cost.*

DISC TYPE; SELF-LAPPING—Metal-to-metal seat. Air tight. Packless.

PILOT CONTROLLED; PISTON OPERATED—Only light touch required; air does the work—shifts the main valve.

PRECISION ENGINEERED—Simple, compact, self-contained; rugged! Try one today. *Ask for bulletins.*

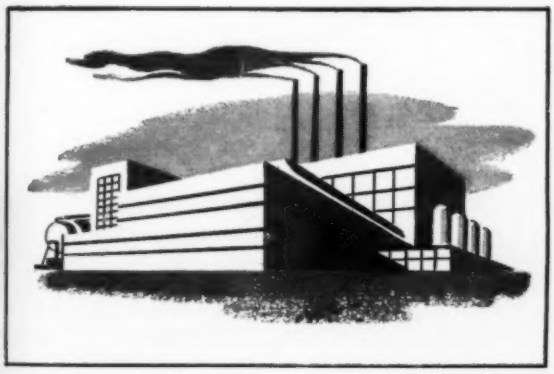
HANNIFIN *Corporation*
1155 S. Kilbourn Ave. • Chicago 24, Illinois

Bendix-Skinner

ORIGINATOR OF **MICRONIC** FILTRATION

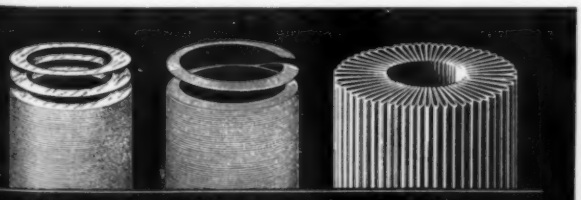
the *Finest*

Way to Make Liquids Come Clean



Nine times out of ten ***Bendix-Skinner*** filters will supply the "finest" answer to your problem. No magic—just the simple fact that ***Bendix-Skinner*** has developed entirely new and exclusive filtering techniques in twenty years of tackling the tough jobs. We'll welcome an opportunity to prove it. An inquiry costs you nothing and may save you much.

***Over 350 Models** providing filtration from 1/2 micron (.000019") upwards at flow rates from 1 to 5000 g.p.m.*



Disc-type *Ribbon-type* *Pleated-type*

SKINNER PURIFIERS DIVISION OF

1500 TROMBLY AVENUE,
DETROIT 11, MICHIGAN

Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Ave., N. Y. 11, N. Y.

MORE ~~HORSEPOWER~~ TORQUE *in a* SMALLER *Package*

NEW DENISON (Series 400) FLUID MOTOR

A new high in *compact fluid power*. You can get up to 24 hp output from this husky, heavy-duty motor — yet it's less than a foot long. Its rugged, close-coupled, axial-piston action takes sudden stops, starts and reversals with trouble-free ease. Unusual compactness makes it easy to adapt to equipment that puts space at a premium. Operates at 2500 psi, with speeds up to 3000 rpm and a torque rating of over 500 inch-pounds. Flange or foot mountings. Check the chart below for an idea of the wide range of industrial needs this new "400 series" HydrOILic Fluid Motor can meet . . . then send for bulletin FM-2 for the full story. Write today!

SPEED	Max. r.p.m. output, shaft	3000
	Min. r.p.m. output, shaft	100
VOLUME	Cubic inches per rev. output, shaft	1.27
	G.p.m. per 100 r.p.m. output, shaft	.55
	G.p.m. at max. r.p.m. output, shaft	16.8
	Volumetric efficiency, % of max. r.p.m.	93
TORQUE	Pound-inches per 100 p.s.i.	24
	Pound-inches at max. p.s.i.	510
	Stalled or starting torque, % of max.	88
	Running torque, % of max.	93
HORSEPOWER	Per 100 r.p.m. at max. p.s.i.	.96
	At max. r.p.m. and max. p.s.i.	24

The DENISON Engineering Company
1166 Dublin Rd. Columbus 16, Ohio

DENISON HydrOILics

1950 National Conference on Industrial Hydraulics Announced

The sixth annual National Conference on Industrial Hydraulics will be held October 18 and 19 at the Sherman Hotel in Chicago, according to an announcement by conference director Otto J. Maha.

Sponsoring the conference are Armour Research Foundation of Illinois Institute of Technology and the Graduate School of the Institute in cooperation with seven Chicago technical societies: American Society of Civil Engineers, American Society of Mechanical Engineers, Society of Automotive Engineers, Western Society of Engineers, American Society of Lubricating Engineers, American Institute of Chemical Engineers and the Institute of the Aeronautical Sciences.

Group Analyzes Hydraulic Circuits

The Cleveland Engineering Society, Machine Design Division, is sponsoring a series of five lectures and demonstrations on simple hydraulic circuits during April and May.

The first lecture, April 4th, presented by R. L. Hall covered simple circuits with a discussion of building a library of hydraulic references. Paul Simonds presented "Standard Work Circuits", at the second meeting, April 18th.

The third in the series was a demonstration of hydraulic circuit applications by C. J. Dudley of Miller Motor Co., who conducted a tour through the "College of Cylinder Knowledge", a mobile trailer fitted with an operating display.

The fourth lecture was held May 2nd; Paul Simonds presented "Standard Control Circuits". The fifth and concluding lecture will be held May 16th at which time A. L. Miller will present his paper entitled "Hydraulic and Electrical Analogies".

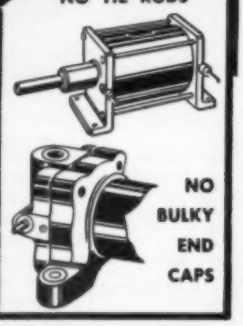
Index to Advertisers

Adel Precision Products Corp. 8
Aeroquip Corporation ..... Cover 3
American Crucible Products Co., The 36
Arrowhead Rubber Co. 40
Brown & Sharpe Mfg. Co. 1
Chiksan Company 37
Commercial Shearing & Stamping Co., The 19
Darling Valve & Mfg. Co. 27
Denison Engineering Co. 47
Electrol Incorporated 4
Fulflo Specialties Co., Inc. 32
Gerotor May Corp. 34
Goshen Rubber & Mfg. Co., Inc. 31
Greer Hydraulics, Inc. 7
Hanna Engineering Works 41
Hannifin Corporation 46
Hufford Machine Works, Inc. 34
Hydraulic Equipment Co. 9
Hydro-Line Mfg. Co. 42
Linear, Inc. 43
Marvel Engineering Co. 43
Miller Motor Co. 6
National Pneumatic Co., Inc. 46
Numatics 48
Oilgear Co., The 39
Ortman-Miller Machine Co. Inc. 48
Pesco Products Div., Borg-Warner Corp. ..... Cover 2
Petch Manufacturing Co. 35
Plastics and Rubber Products, Inc. 21
Plastic & Rubber Products Co. 45
Raybestos-Manhattan, Inc. 44
Resistoflex Corporation 42
Roper Corporation, Geo. D. 33
Ross Heater & Mfg. Co., Inc. 29
A. Schrader's Son, Div. of Scovill Mfg. Co., Inc. 37
Sealol Corp. 38
Skinner Purifiers, Inc. 47
Sundstrand Machine Tool Co., Hydraulic Division 23
Texas Company, The 10
Tomkins-Johnson Co., The 28
Valvair Corporation 39
Waterman Engineering Co. 36
Weatherhead Company, The 2-3

SPACE-SAVING CYLINDERS

PACK POWER IN MINIMUM AREA

NO TIE RODS



1½ to 8" bores available for prompt delivery

NO BULKY END CAPS

O-M hydraulic, water, air cylinders save up to ⅓ in space required. Unique circumferential key locks honed steel tubing to compact end caps . . . yet disassembly is a matter of seconds. Ports oriented radially to infinite number of positions. All mounting brackets available. Steel (no castings) and bearing bronze throughout. *Write today for specifications.*

ORTMAN-MILLER

MACHINE CO., INC.

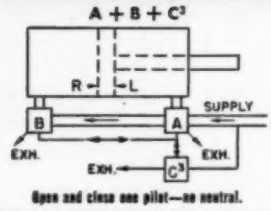
1204 150th Street, Hammond, Indiana

SOLVE AIR PROBLEMS

Easy as A, B, C - -

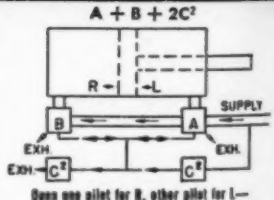
WITH UNITIZED CONTROL

A + B + C²



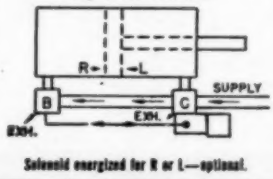
Open and close one pilot—no neutral.

A + B + 2C²



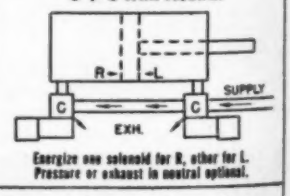
Open one pilot for R, other pilot for L—no neutral.

B + C No Neutral



Solenoid energized for R or L—optional.

C + C With Neutral



Energize one solenoid for R, other for L. Pressure or exhaust in neutral optional.

A = L3A Numatics Valve
B = L3B Numatics Valve
C = SL3 (L3A with solenoid pilot attached)
C² = Two-way pilot valve
C³ = Three-way pilot valve

Shown here are a few typical combinations obtained with "Unitized Control" . . . applied directly to the air cylinder.

INCREASE PRODUCTION —LOWER COSTS

Send for Catalog

NUMATICS

102 SOUTH MAIN ST. • MILFORD, MICH.

"BREAKAWAY"

For efficient operation of hydraulically-controlled implements, the Aeroquip "Breakaway" Coupling is the ABC rule. This rugged, field-proven unit provides two important services: it eliminates the breaking of hose lines and loss of hydraulic fluid whenever the implement breaks away from the tractor; it permits quick, easy connection and disconnection of implements and tractor. (Photo courtesy of International Harvester Company.)

Aeroquip

The "Breakaway", consisting of twin Self-Sealing Couplings mounted on a frame, connects both hydraulic pressure and return lines between tractor and pull-behind implements. The "Breakaway" can be separated by a tug on either hose line or by tripping the trigger manually. When uncoupled, both halves seal automatically keeping hydraulic fluid in and preventing dirt and air from entering the hydraulic system. The "Breakaway" can be reconnected easily even when under pressure. Operation is simple and foolproof.

Always first

REG. TRADE MARK

AEROQUIP CORPORATION

JACKSON, MICHIGAN

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Mr. Businessman!

WHAT WILL THE 1950 CENSUS DO FOR YOUR BUSINESS?

CONSUMER MARKET INFORMATION

The 1950 Census will provide a huge amount of information about the characteristics of the consumer market. It will tell you what kind of income groups live where . . . what they have and what they need in the way of commodities from automobiles to television sets down to plumbing fixtures. The Census is an accurate survey of economic conditions in your market area. It will not only tell you *where* your customers are, but *what they need that you have to sell them!*

It will show where improved transportation and shipping facilities are needed . . . better harbors and waterways . . . stepped-up Public Service.

That is why the 1950 United States Census is vital to your business!

COOPERATION

You know that the Census-Taker is not just "counting heads." He's actually making a survey of existing conditions in industry, business, employment, housing, education. *You* know census information is as confidential as the vote you cast! Because you know all these things *you'll* cooperate with the Census-Taker in every way when he calls on you.

WHAT ABOUT THE OTHER FELLOW?

But! What about the people who work for you? The man in the shop . . . your own secretary . . . the fellows in the shipping room. Do they know all this about the Census? Chances are some of them do, so the idea is to get the right information across to those who don't!

WHAT'S THE BEST WAY?

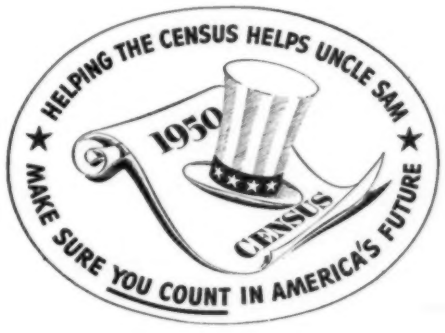
If it's possible, call everyone together and talk about it . . . ask questions . . . exchange ideas. If your outfit is too big for that, direct a Census information memorandum to all your employees. Post information on the bulletin boards. Run a Census story in the company house organ. Talk about it. *Every way you can . . . get the people who work for you to cooperate with the Census.*

WHAT DOES THE 1950 CENSUS MEAN TO YOUR EMPLOYEES?

Better schools . . . school buses . . . school lunches. It means finer roads, bridges and highways . . . increased transportation facilities . . . improved safety regulations. It creates more efficient Public Service and furthers adequate distribution of utility services such as telephones, gas, water and electric power. It will help your community plan better parks, playgrounds, recreation areas and housing. It will mean higher living standards and accurate congressional representation. The Census is *everybody's voice in America's future!*

YOU OWE IT TO YOURSELF . . .

Mister Businessman . . . to your business and your community! Put your efforts behind the 1950 United States Census for an even better country to live in . . . the *best* country to do business in!



Like other American business firms, we believe that business has a responsibility to contribute to the public welfare. This advertisement is therefore sponsored by

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